

SEAFDEC Asian Aquaculture



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Agrikulturang



MakaMASA

Makapagpabagong Programa Tungo sa Masagana
at Maunlad na Agrikultura at Pangisdaan



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Four departments were established in the Member-Countries; the Aquaculture Department (**AQD**) located in the Philippines pursues aquaculture research and development.

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Contributions

We accept articles that focus on issues, developments, and information on all phases of sustainable aquaculture for publication in this newsletter. Photographs and line drawings must be camera-ready, glossy B&W prints or colored slides. The newsletter editor reserves the right to edit contributed articles for brevity and style.

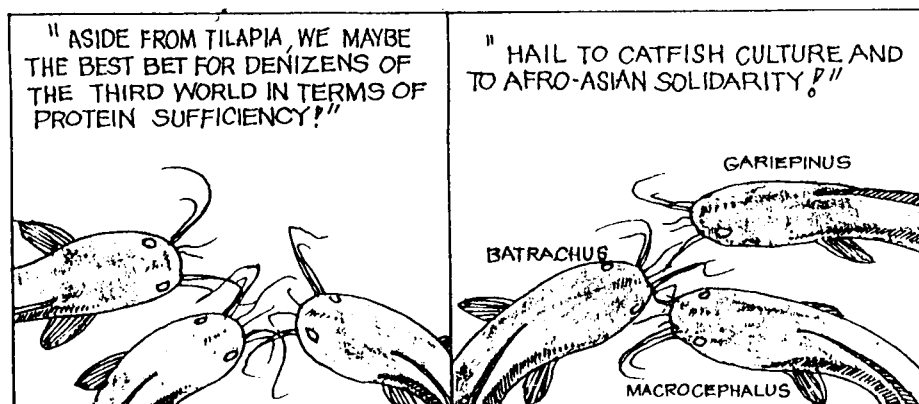
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Nota bene Mention of trade names in this publication is not an endorsement.



Our cover

Harvest of catfish in a government demonstration center in Pangasinan, northern Philippines

Photo by RY BUENDIA

SEAFDEC/AQD looks forward to a new decade

■ Aquaculture is one of the fastest growing food-producing sectors in the world, and the demand for foodfish is ever increasing as we strive to meet the need of the burgeoning population.

Since its establishment in 1973, SEAFDEC/AQD has contributed greatly to aquaculture development. This department has made important advances in aquaculture research and has become established as a leading aquaculture center in the region.

Appropriate aquaculture technologies and technical advances have been developed for marine fishes (grouper, milkfish, red snapper, sea bass, rabbitfish, marine ornamental fish), freshwater fishes (native catfish, tilapia, bighead carp), crustaceans (mudcrab, giant tiger shrimp), mollusks (abalone, window-pane shell) and seaweeds. There are also studies on environmental and socio-economic concerns in aquaculture including coastal resources management, mangrove-friendly aquaculture, lake ecology and biodiversity conservation. Moreover, we have embarked on aquaculture

By
ROLANDO PLATON, PhD



biotechnology and genetics research to keep abreast with the latest issues in the field.

All our researches are aimed at answering four critical areas of national and regional concern: poverty alleviation, food security, environment-friendly technology and export and cash crops.

On the other hand, research results would be useless if not applied, extended or shared with the target clientele: the fish farmers, research and academic institutions, policy makers, regional and international organizations, member countries, public and the private sector. Therefore, three major technology transfer strategies are continuously done to facilitate dissemination: technology verification, packaging and commercialization; training and extension delivery systems; and media strategies.

As we enter into another era of aquaculture research and development, SEAFDEC/AQD views the coming years with much enthusiasm. We shall consciously strive to develop technologies that respond to our objective of making aquaculture sustainable and responsible. ■

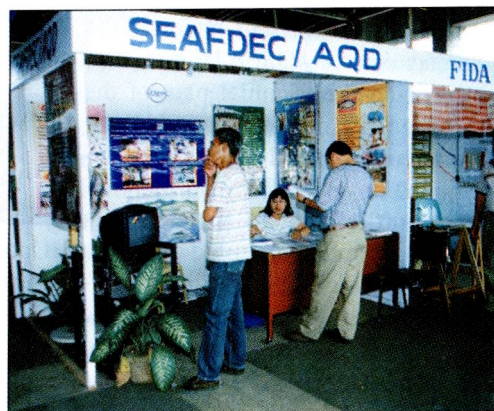
AQD's major activities



Technology generation through research



Technology verification and demonstration



Training and information dissemination

Myanmar joins SEAFDEC



The flag of the Union of Myanmar unfurls at SEAFDEC's aquaculture department in Tigbauan, Iloilo

The Union of Myanmar (formerly Burma) is now the eight member country of SEAFDEC.

The membership became official after the government of Myanmar deposited the Instrument of Accession last November 8 to Thailand which

is the depository government of the agreement establishing SEAFDEC. Myanmar also appointed U Than Tun, director general of the Department of Fisheries as SEAFDEC council director, and U Hla Win, the deputy director general, as the alternate council director.

SEAFDEC-JICA training



Sixteen trainees from Asia and Africa are currently attending SEAFDEC/AQD's first international training course this year. The first session of Phase 2 of the *Third-Country Training Programme on Responsible Aquaculture Development* is a joint project with Japan International Cooperation Agency (JICA). The course runs from January 18 to March 17. A second session has been scheduled for August-October.

The trainees have had local experience on resource and socioeconomic assessments and mangrove-friendly aquaculture when they visited Aklan for a week.

BBC covers aquaculture



BBC interviews Dr. Jurgenne Primavera on mangrove-friendly aquaculture

Crew of the British Broadcasting Corporation's *Blue Planet* program visited SEAFDEC/AQD in the third week of January to get a glimpse of the progress of the aquaculture industry, and its efforts in institutionalizing sustainable practices in the wake of the disease outbreaks.

Year 2000 R&D roundtable

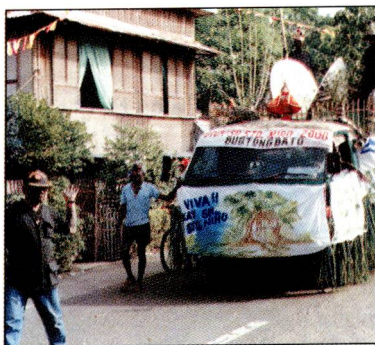
The annual roundtable workshop on SEAFDEC/AQD activities was held 17-18 January at AQD's main offices in Tigbauan.

Senior researchers, training-information, and management staff reviewed the recommendations of ADSEA IV, discussed and prioritized the triennial plan of the various programs and projects, and identified research studies and activities for implementation in year 2000.

One of the newest programs is biotechnology, initially focused on tilapia (selective breeding), tiger shrimp (development of founder population for specific disease resistant strain), and rabbitfish and milkfish (cloning of growth hormones which can facilitate rapid growth).

The workshop was conceptualized and organized by Dr. Clarissa Marte, head of AQD's research division.

Aquasilviculture float



Upon the invitation of the Ibajay local government in Aklan, SEAFDEC/AQD participated in this year's *ati-atihan* float contest in celebration of the town fiesta on January 23.

The float produced by the collaborative efforts of Brgy. Bugtong Bato and AQD won the contest among a group of eight from different barangays. The float



depicted the various commodities that can be raised in mangrove areas like mudcrab and molluscs. Organizers noted that it was a great way to publicize AQD's mangrove-friendly aquaculture project in the locality and build awareness on sustainability issues. ###



AQD Research Publications

Reprints of papers listed here may be requested directly from AQD authors or from the AQD Library

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Agbayani RF, Baticados DB, and Siar SB. 2000. Community fishery resources management on Malalison island, Philippines: R & D framework, interventions, and policy implications. *Coastal Management* 28: 19-27

Abstract. In 1991, the Aquaculture Department of the Southeast Asian Fisheries Development Center launched a community-based fishery resources management project on Malalison Island, in central Philippines, to help conserve the country's marine resources and to help the fisherfolk rise above their poverty. The eight-year project integrated various disciplines in biology, economics, sociology, public administration, and engineering in its study of fishery resources and fishing communities and in evolving intervention strategies for resource conservation and management, and for community development. The project's most important accomplishment was the inculcation among the fisherfolk of the importance of resource conservation and management. The most important lesson learned was that an enlightened and empowered fisherfolk could be effective managers and responsible users of fishery resources.

Ayson FG, de Jesus EGT, Amemiya Y, Moriyama S, Hirano T, and Kawauchi H. 1999. Isolation, cDNA cloning, and growth promoting activity of rabbitfish (*Siganus guttatus*) growth hormone. *General and Comparative Endocrinology* 117: 251-259

Abstract. We report the isolation, cDNA cloning, and growth promoting activity of rabbitfish (*Siganus guttatus*; Teleostei; Perciformes; Siganidae) growth hormone (GH). Rabbitfish GH was extracted from pituitary glands under alkaline conditions, fractionated by gel filtration chromatography on Sephadex G-100, and purified by high-performance liquid chromatography. The fractions containing GH were identified by immunoblotting with bonito GH antiserum. Under unreducing conditions, the molecular weight of rabbitfish GH is about 19 kDa as estimated by SDS-PAGE. The purified hormone was potent in promoting growth in rabbitfish fry. Weekly intraperitoneal injections of the hormone significantly accelerated growth. This was evident 3 weeks after the start of the treatment, and its effect was still significant 2 weeks after the treatment was terminated. Rabbitfish GH cDNA was cloned to determine its nucleotide sequence. Excluding the poly (A) tail, rabbitfish GH cDNA is 860 base pairs (bp) long. It contained untranslated regions of 94 and 175 bp in the 5' and 3' ends, respectively. It has an open reading frame of 588 bp coding for a signal peptide of 18 amino acids and a mature protein of 178 amino acid residues. Rabbitfish GH has 4 cysteine residues. On the amino acid level, rabbitfish GH shows high identity (71-74%) with GHs of other perciforms, such as tuna, sea bass, yellow tail, bonito, and tilapia, and less (47-49%) identity with salmonid and carp GHs.

Garcia LMB, Garcia CMH, Pineda AFS, Gammad EA, Canta J, Simon SPD, Hilomen-Garcia GV, Gonzal AC, Santiago CB. 1999. Survival and growth of bighead carp fry exposed to low salinities. *Aquaculture International* 7(4): 241-250

Abstract. Bighead carp (*Aristichthys nobilis* Oshima) fry of various ages (11, 18, and 35 days post-hatch) were exposed to the low salinities encountered during the annual intrusion of seawater in Laguna Lake, Philippines. Practical indices of salinity tolerance assessed the effect of a 96 h direct exposure to low salinities (0-16 parts per thousand). Mean (MST) and median survival times (MST50) of fry decreased as salinity of rearing medium increased. Younger fry were less able to tolerate exposure to these salinities than their older cohorts. Median lethal salinity after 96 h (MLS) revealed higher tolerance among 35-day old fry (7.6 parts per thousand) than 11 (2.3 parts per thousand) and 18-day old fry (6.0 parts per thousand), demonstrating that survival in saline water depends on their age at initial exposure to low salinities. Mean body weight of 18-day old fry reared in 0 and 2 parts per thousand for 3 and 4 weeks was higher than for those reared in 4 and 6 parts per thousand for the same period. Growth over these periods was inversely related with the range of salinities tested. These results demonstrate that, despite their known stenohalinity, bighead carp fry possess some degree of osmoregulatory capability, allowing them to survive and grow in lakes subjected periodically to saltwater inflow.

Note: Abstracts from journals covered by *Current Contents* are downloaded from the CD-Rom version (Agriculture, Biology & Environmental Sciences; 1 February 1999 - 24 January 2000). 2000. Institute for Scientific Information, Pennsylvania, USA.

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Minoso MGG, Borlongan IG, Satoh S. 1999. Essentiality of phosphorus, magnesium, iron, zinc, and manganese in milkfish. *Fisheries Science* 65(5): 721-725

Abstract. Six semi-purified casein based diets were formulated to contain either a complete mineral mixture (control) or mineral premixes from which, a specific test mineral was deleted to obtain phosphorus (P)-free, magnesium (Mg)-free, iron (Fe)-free, zinc (Zn)-free, or manganese (Mn)-free diets. These diets were fed to juvenile milkfish (mean initial weight 2.600.08 g) for a 22-week experimental period. Final mean percent weight gain ranged from 1022 to 1379% with P-free (1022%) and Fe-free (1066%) diets obtaining a significantly lower weight gain ($p < 0.01$) than the control diet (1270%). Survival was greater than 90% and did not differ significantly among treatments. Upon termination of the growth experiment, milkfish flesh, bones, and combined samples of head, skin, and scales were dissected and analyzed for ash, P, Ca, Mg, Fe, Zn, and Mn content. The deletion of P or Fe from mineral mixture lowered P content in flesh and bone. Zn content in bone of fish was also lowered by exclusion of Zn, Mn, Mg or Fe. The result of this study demonstrated that it is necessary to supplement P and Fe even to semi-purified casein based diets.

Richter H, Focken U, Becker K, **Santiago CB, Afuang WB.** 1999. Analysing the diel feeding patterns and daily ration of Nile tilapia, *Oreochromis niloticus* (L.), in Laguna de Bay, Philippines. *Journal of Applied Ichthyology* 15 (6): 165-170

Abstract. Cage cultured Nile tilapia, *Oreochromis niloticus*, were sampled at a commercial set-up on two occasions in 1995 in Laguna de Bay, Philippines, each

time over a 24 h cycle. The stomach content weights were averaged for each subsample and analysed with the computer model MAXIMS. The model predicted that, in May, larger fish (mean total weight: 31.5 g) feeding on natural food alone fed continuously from dawn to dusk, ingesting 5.1 % body mass equivalent (% BME, wet weight basis) whereas smaller fish (mean total weight: 9.8 g) had two feeding periods per day, from sunrise to mid-morning and again from mid-afternoon until after sunset, ingesting 13.7 % BME. In August, fish were given supplemental feed once daily at 07:00 h. These fish (mean total weight: 81.7 g) fed intensely until supplemental feed ran out before mid-day, after which some ingestion of natural food took place later in the day. The fish ingested 5.8 % BME supplemental feed and 5.1% BME natural food per 24 h. In May, most of the stomach contents consisted of the blue-green alga *Anabaena spiroides*, whereas in August, the natural food was made up principally of detritus.

Sumagaysay NS. 1999. Feed ration for different sizes of wild and hatchery-bred milkfish (*Chanos chanos* Forsskal). *Aquaculture Research* 30(10):789-792

Short communication / no abstract

Sumagaysay NS, Hilomen-Garcia GV and Garcia LMB. 1999. Growth and production of deformed and nondeformed hatchery-bred milkfish (*Chanos chanos*) in brackishwater ponds. *The Israeli Journal of Aquaculture - Bamidgeh* 51 (3)

Abstract. This study evaluated the growth and survival of morphologically deformed hatchery-bred milkfish in brackishwater ponds. It compared the size-frequency dis-

tribution of the non-deformed fish with the deformed ones, and determined the effects of different types of deformity on growth. The deformities include the absence of an upper jaw, a folded operculum with gills exposed, a cleft branchiostegal membrane, scoliosis, etc. The results were compared with production of wild stock. Hatchery-bred and wild milkfish fry were grown separately in nursery ponds (500 m²/pond) at 10 individuals/m². After a month, the juveniles (average weight hatchery-bred 6.0 g; wild 9.5 g) were transferred to seven rearing ponds of 1000 m² each (stocking density 3000/ha). Three ponds were stocked with selected, nondeformed hatchery-bred fish (1:2 ratio; mixed stock), and one pond with wild fish. The final weight, specific growth rate and survival of the nondeformed fish (mixed and unmixed stock) after four months of culture were significantly higher ($p < 0.05$) than those of the deformed fish. Production, however, did not significantly differ between the unmixed nondeformed (433 kg/ha) and the mixed deformed and nondeformed (377 kg/ha) fish. Survival of the deformed stock (56%) was significantly lower ($P < 0.05$) than that of the nondeformed stock (86-88%). Approximately 92% of the deformed stock and 17-20% of the nondeformed were below 150 g. Severe deformities such as the absence of an upper jaw and exposure of all or most of the gills hindered fish growth, while widening of the operculum or branchiostegal membrane, scoliosis, or absence of the anal fin had less effect on growth. To lower the incidence of deformities in grow-out ponds, milkfish fry should be reared to the early juvenile stage in nursery ponds for at least a month. The harsh natural conditions in the nursery ponds (e.g., presence of predators, abrupt changes in salinity, temperature and dissolved oxygen) and stress during transfer to rearing ponds may eliminate most of the weak fish and those with severe deformities.

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Establishing a mangrove nursery

By

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Mangroves play an important role in creating habitats for a diverse community of organisms ranging from bacteria and fungi to fishes and mammals. They also provide aesthetic beauty, protect shorelines, reduce the impact of storm surges as well as produce timber, fuelwood, honey and other bee products, organic fertilizers, medicines and livestock feeds. Mangrove trees and shrubs grow in intertidal flats, estuaries and off-shore islands.

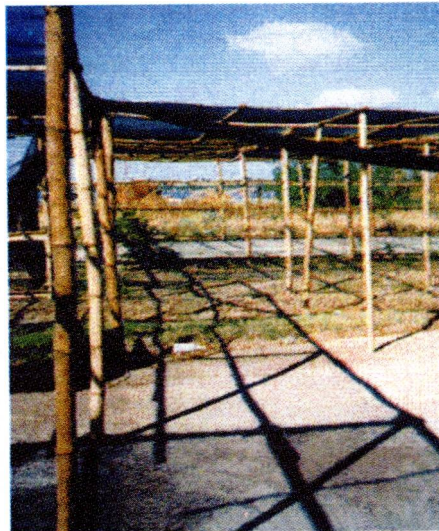
Mangrove forests are called "forests of the sea." They are highly productive ecosystems. But they are under continuous threat from man-made activities. The global destruction of mangroves is caused primarily by dumping of garbage and pollutants; clearing for housing, agricultural, and fishpond development; urbanization; resorts and other recreational pursuits.

In the Philippines, mangrove forests have dramatically decreased in area since the start of the century when about 400,000 to 500,000 ha of mangrove stand existed (Brown & Fisher 1918). By 1988, only 139,725 ha were left (NAMRIA 1988). This represents a 70% reduction of the country's total mangrove forest.

The need to reforest is everybody's concern. But first, mangrove nurseries must be established as these serve as sources of planting materials for different mangrove species. Furthermore, nurseries would mean sustainable source of livelihood for coastal communities because of continuous demand for propagules.

Mangrove seedlings are raised in the nurseries for 3 to 5 months depending on the species before out-planting. For the eight species studied and presented here, the cost of production ranges from P422.50 to P1,150.00 per 500 seedlings (1998 prices). There are six insect pests attacking the seedlings and two diseases have been identified. However, control measures have been developed.

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*Mangrove nursery made up of
bamboo poles with fish net and coconut
fronds as roofing material*

Why establish a mangrove nursery?

Many think that mangrove nurseries are not necessary since it is very easy to plant mangroves; that is, stick the propagules in the mud and you have planted one. Probably they are thinking only of the bakauan (*Rhizophora*) species which has long propagules. But there are many mangrove species and most have small seeds or propagules like the "nilad." Besides, there are pests that consume fresh propagules planted on muddy shores.

A nursery is a place where seedlings are raised and handled until they are ready for permanent planting. It is an essential part of reforestation programs and industrial plantations. It can produce healthy planting stocks and subsequently high survival when outplanted.

Another reason for establishing a nursery is protection from pests such as crabs which feed on the cambium layer of the propagules and defoliate newly planted plants. Barnacles also pose a problem. When propagules are planted directly, the barnacles will cling to young plants, strangling them to death. Larger plants raised in the nursery will assure survival since the barnacles could no longer enclose them. As the plants grow larger in diameter, the barnacles fall off.

Mangrove plants are also raised to bigger sizes in the nursery to withstand the inhospitable conditions of denuded or degraded and open coastal environments. -- VS/SB

Establishing the nursery

Nurseries can be permanent or temporary. Permanent nurseries are established to produce a large number of seedlings for extensive reforestation projects. Although construction is quite expensive, production of good quality seedlings is assured.

Temporary nurseries are appropriate when target planting areas are far from permanent nurseries. They are less expensive to construct, and the seedlings are raised in a vegetation zone with similar conditions to the areas to be planted.

Generally, most mangrove nurseries are temporary to save time, labor and capital.

Selecting the site

There are a number of factors to be considered in site selection: availability of water, drainage, accessibility, size and topography. Therefore, choose a site that is:

- along streams near a brackishwater source or in areas where freshwater can be easily obtained
- flat for easy accessibility. Be sure to have good drainage to avoid flooding during the rainy season and in times of exceptionally high tide occurrences
- near the target plantation area to minimize handling injury during transport
- large enough for expansion. The size will depend on the target number of seedlings and the kind of species to be raised. A crowded nursery will only result in inferior planting stock

Nursery construction

The construction of the nursery follows. Temporary mangrove nursery can be constructed using local materials like bamboo poles, coconut fronds and used fish nets. Table 1 presents the approximate cost needed in the construction of a temporary mangrove nursery.

Preparation of potting materials

Mangroves, being generally viviparous, germinate easily. Once they mature, propagules (of *bakauan*, *malatanggal*, *tangal* and *pototan*) start to germinate after falling to the ground.

Know the Philippine species of mangroves

The Philippine mangrove flora is rich in species composition consisting of 47 "true mangrove" and associated species belonging to 26 families (Melana et al. 1997). True mangrove species are those that strictly grow in the brackishwater or saline environment while associated species may thrive in other habitat types such as the beach forest, and lowland areas. Below is a listing of the most common true mangrove species. - VS/SB

Family	Species	Local name
Avicenniaceae	<i>Avicennia officinalis</i> L.	Api-api
	<i>A. marina</i> (Forsk.) Vierh.	Bungalon
	<i>A. alba</i> Blume	Bungalon-puti
	<i>A. lanata</i> L.	Piapi
	<i>A. eucalyptifolia</i> (Zipp. ex Miq) moldenke	Bungalon-sahing
Bignoniaceae	<i>Dolichandrone spathacea</i>	Tui
Bombacaceae	<i>Camptostemon philippinense</i> (Vidal) Becc.	Gapas-gapas
Combretaceae	<i>Lumnitzera littorea</i> (Jack) Voigt.	Tabau
	<i>L. racemosa</i> Willd.	Kulasi
Euphorbiaceae	<i>Excoecaria agallocha</i> L.	Buta-buta
Lythraceae	<i>Pemphis acidula</i> Forst.	Bantigi
Meliaceae	<i>Xylocarpus granatum</i> Koen	Tabigi
	<i>X. moluccensis</i> (Lamk.) Roem.	Piagau
Myrsinaceae	<i>Aegiceras floridum</i> Roem. & Schult.	Tinduk-tindukan
	<i>A. corniculatum</i> (L.) Blanco	Saging-saging
Myrtaceae	<i>Osbornia octodonta</i> F. Muell.	Taualis
Palmae	<i>Nypa fruticans</i> (Thunb.) Wurb.	Nipa
	<i>Oncosperma tigillarium</i> (Jack) Ridl.	Anibong
Rhizophoraceae	<i>Rhizophora apiculata</i> Bl.	Bakawan lalake
	<i>R. mucronata</i> Lank.	Bakawan babae
	<i>R. stylosa</i> Griff.	Bakawan bato/b. bankau
	<i>Ceriops tagal</i> (Perr.) C.B. Robinson	Tangal
	<i>C. decandra</i> (Griff.) Ding Hou	Malatanggal
	<i>Bruguiera cylindrica</i> (L.) Bl.	Pototan lalake
	<i>B. gymnorrhiza</i> (L.) Lamk.	Busain
	<i>B. parviflora</i> Wight & Arnold ex Griff.	Langarai
	<i>B. sexangula</i> (Lour.) Poir	Pototan
	<i>Scyphiphora hydrophyllacea</i> Gaerthn.	Nilad*
Rubiaceae	<i>Sonneratia alba</i> J. Smith	Pagatpat
Sonneratiaceae	<i>S. caseolaris</i> (L.) Engl.	Pedada
	<i>Heritiera littoralis</i> Dryand. Ex W. Ait.	Dungon-late

*An important historical mangrove species where Manila (*May Nilad*) got its name.

REFERENCES

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- ADB/Crown Agents. 1990. Mangrove development project. Feasibility study. Volume 2. Final Report

In nursery practices, pure soil is not recommended because there is a possibility of compaction, thus affecting the roots and root development of the young seedlings. The combination of soil and coconut

coir dust (other porous soil conditioner may be used) is the best potting media in mangrove species propagation. The ratio is 2:1. soil-to-coconut coir dust. The latter pro-

Role of vitamins C and E in immune response of fishes

By

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The immune system of animals is a biochemical complex of structure (lymphocytes, T-cells and B-cells, Kupffer's cell of the liver and leukocytes) and processes (formation of antigens and antibodies, phagocytosis, others) to protect against foreign bodies like tumors and toxins.

In the case of fish, the immune responses are influenced by many factors, including stress, hormonal changes, seasonal effects, intercurrent infections, drugs and environmental pollutants. Fishes are protected from infections, transformed cells and other invaders by several interdependent mechanisms.

Nutrition is one of the factors enabling the host to resist diseases by antibody synthesis and cellular immune response. Cells involved in the generation of specific and non-specific immune responses are metabolically activated and are most likely affected by vitamin deficiencies. For example, the break down of the first barrier against infection -- the skin -- may be due to deficiencies in protein, zinc and the vitamins A and C.

Nutritional immunology with regard to fishes as a separate discipline is a very new concept although a considerable amount of studies has been done in human cases and land animal models. But it may be the incomplete knowledge about the nutritional requirements of different fishes that had led to the neglect of this field. Vitamins are the most important micronutrients, the deficiencies or excessiveness of which has profound impact on disease development and survival of cultured fishes.

Alterations in immune responses occur when a decrease in micronutritional intake causes a corresponding decrease in body reserves. Immunological abnormalities predict the risk of infection and mortalities. Excessive intake of micronutrients is associated with impaired immune response. Most of the studies on

fishes have been carried out for high or pharmacological doses of vitamins, and are restricted only to vitamins C and E. These vitamins are the most important antioxidants in the diet (Lall & Oliver 1991). Tests for immunocompetence are important so safe levels can be established.

Non-specific and specific adoptive elements have shown in-vitro activity associated with resistance against pathogens. But several immune functions have not been characterized.

Vitamins and fish immunity

Research on vitamin nutrition in relation to the immunity in fishes is very limited (Lall & Oliver 1991). Among the vitamins, the antioxidants (vitamins C and E) are found to have an impact on the immune system of fishes (Furanose *et al.* 1992, Verlhac *et al.* 1996).

B-complex vitamins are involved in cellular metabolism by acting either as enzyme activators or coenzymes (thiamin, riboflavin, pantothenic acid, folic acid, niacin, pyridoxine and cyanocobalamine).

Significant modulations in the immune system were found on chinook salmon (*Oncorhynchus tshawytscha*) fed different levels of pyridoxine (Leith *et al.* 1986). However, enhanced levels of vitamins could not elucidate any effect on the immune system of Atlantic salmon

(Albrektsen *et al.* 1995). The effect of folic acid on the disease resistance and its interaction with ascorbic acid were proven in channel catfish (*Ictalurus punctatus*). Serum antibody titres on bacterial challenge studies revealed a direct relationship between dietary folic acid content and disease resistance. When enhanced levels of vitamin A were fed to Atlantic salmon, its kidney leukocyte migration and serum bacterial activity were found to be increased, whereas the phagocyte burst activity and eicosanoid production were unaffected (Thompson *et al.* 1994).

Two types of the non-specific defense mechanism are noted in fishes. The first is the complement system consisting of a series of proteins which can be activated as an alternative or a classical pathway. The alternative pathway is non-specific, achieved by various structures possessing repeating units, whereas the classical pathway is the activation of the complement system specifically by the antibodies attached to surface antigens.

The second important non-specific defense mechanism is phagocytosis, a cellular process involving the ingestion of foreign material by specialized cells, such as macrophages and the neutrophils or polymorphonuclear neutrophils.

Basically, specific immunity is characterized by the initial interaction between antigens and lymphocytes. Two populations of lymphocytes are recognized: B-lymphocytes and T-lymphocytes. Both are responsible for humoral and cellular immunity, respectively, whose memory component has been demonstrated in fish.

Humoral immunity is mediated by B-lymphocytes which respond to stimulation with a variety of antigens. B-lymphocytes transform into plasmocytes which produce antibodies specific for the stimulating an-

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tigen. The humoral response is dependent on the nature, dose and route of antigen exposure. Antibodies can also interact with the non-specific immune system by activating the classical pathway of the complement system or by acting as opsonins. Cell-mediated immunity is dependent on the presence of T-lymphocytes and this type of immunity can be transferred passively with T-lymphocytes only and not with serum. It can be activated by using certain adjuvant and intercellular pathogens given as attenuated live vaccines.

Vitamins and immune responses

Panush & Delafuente (1985) reviewed the biological functions of vitamin C in living organisms as a general water soluble redox reagent, cofactor in collagen synthesis, growth activator, regulator of hormone synthesis, modular of hexose monophosphate shunt and indicator of hepaticmicrosomal hydroxylase and as a immunostimulator in fish.

In-vitro studies have demonstrated that vitamin C stimulates the production of interferon and enhances the chemotactic response of neutrophils. The proliferative response of T- and B-lymphocytes including specific antibody production may be also modulated. Several investigations have demonstrated that activities of phagocyte cells, such as random migration, chemotaxis production of hypochlorous acid and modulation of auto-oxidation are all dependent upon ascorbate concentration. Elevated level of ascorbic acid enhances the serum complement activity (Lall & Oliver 1991).

Experimental studies revealed that the effect of vitamin on the immune function of fish is unclear but there is evidence that some non-specific rather than specific immunity may not be directly influenced by dietary vitamin C intake.

Dietary vitamin C exhibits protective effects on pesticide intoxication of both organochlorine and organophosphorous compounds. It can antagonize when administered at high dose (Guha *et al.* 1993). Enhancement of phagocytic ability of potential macrophages and circulating

neutrophils was observed when vitamin C was fed to channel catfish. There was increased hemolytic activity of complement system when ascorbic acid was supplied at 300 mg per kg of feed (Li & Lovell 1985). When elevated level of vitamin C was fed to channel catfish, there was lower incidence of malformations. Channel catfish were also found to be more resistant to ammonia toxicity and lower levels of dissolved oxygen (Mazik *et al.* 1987). According to Wise *et al.* (1988), an ameliorative effect of ascorbic acid on the nitrate-induced methanoglobinemia in channel catfish was noticed with enhanced feeding levels of vitamin C. Channel catfish showed hundred-fold LC₅₀ values than control whereas complement and hemolytic activities were unaffected (Liu *et al.* 1989). Significant increase in antibody levels was obtained with vitamin C supplementation in rainbow trout diet (Navarre & Halver 1989). High levels of antibody production and complement activity in Atlantic salmon could be increased by enhanced levels of vitamin C but failed to produce any effect on the non-specific resistance to vibriosis (Lall *et al.* 1991). So, vitamin C has got beneficial effect on the teleost immune system. The mode of action may be by acting as a break on steroidogenesis through peroxidation of unsaturated lipids, thereby preventing their conversion to cholesterol, an important component of cortisol.

The effect of antioxidant vitamins, i.e. vitamin C, on the immune system is through the tertiary level of stress reactions, with the most marked effect being the elevation of serum complement levels (Hardie *et al.* 1991). The effect may also be apparent at secondary levels of stress reactions. In rainbow trout, increased level vitamin C caused increased complement activity and elevated phagocytic activity by peritoneal macrophages. Higher proliferation of lymphocytes was induced by concavalin A (Verlhac *et al.* 1991). According to Duncan & Lovell (1994), channel catfish show maximum survival and antibody production and minimum blood abnormalities when ascorbic and folic acids were incorporated in the diet.

Verlhac *et al.* (1996) reported that combination of vitamin C with glucan has a stimulatory effect on non-specific parameters except plasma lysozyme.

There are some contradicting reports about vitamin C supplementation and immunomodulation. Elevated ascorbic acid failed to produce any improvement in phagocytic index and bacterial capacities of anterior kidney in channel catfish (Johnson & Ainsworth 1991).

Similarly, vitamin C is required for optimum function of the immune system in homeotherms. It decreases the production of lipid peroxide and reactive oxygen, which are autotoxic and destroy neutrophils and macrophages. Vitamin C functions in the maintenance of membrane integrity in all cells. The phospholipids of mitochondria, the endoplasmic reticulum, and plasma membranes possess special affinities for α -tocopherol.

Blazer & Wolie (1984) reported that the α -tocopherol deficiency suppresses all aspects of humoral and cellular immunity as well as phagocytic index of rainbow trout. Later works revealed that the effect of vitamin E is only on non-specific humoral factors (Hardie *et al.* 1990).

Among blood parameters, only complement activity showed positive correlation with vitamin E consumption.

Epidemiological studies showed that high plasma vitamin E levels can be correlated with the low incidence of infectious diseases but it is very difficult to differentiated the specific action of vitamin E from other dietary antioxidants (Eitenmiller 1997). Furan *et al.* (1992) reported a reduced mortality of rainbow trout even though the exact mechanism was not fully described. The serum antibody levels were found to be unaffected.

Higher levels of vitamin E had more protective effect on the RBC membrane against peroxidant induced lysis (Wise *et al.* 1993). In salmonids, the higher vitamin E supplementation had an enhancement of phytohaemagglutinin (PHA) and lipopolysaccharide-induced lymphocyte proliferation (Verlhac 1991).

'Golden' menace in Ifugao rice terraces

If the golden apple snail (GAS) were real "gold", farmers in the Ifugao Rice Terraces (IRT) would have been grateful to those who brought it to the world-renowned spot in the Philippines.

Now one of the major rice pests in the IRT, GAS has been significantly reducing the current yield of about 1.34 tons per ha annually, which is barely enough to feed the families for the whole year.

Scientifically known as *Pomacea canaliculata* (Lamarck 1822), GAS has been known in the Philippines to habituate only the lowland areas and its reproduction is limited by low temperature, high elevation, and salinity. Surprisingly, a group led by Dr. Ravindra Joshi, a crop protection specialist at the Department of Agriculture-Philippine Rice Research Institute (DA-PhilRice) discovered that GAS can survive in cool, elevated areas as demonstrated by a large number of GAS in the IRT, which is 4,000-5,000 ft above sea level.

Unaware of the possible threats posed by GAS, rural folks in the IRT brought it from the lowland areas for human and animal consumption and for weed control. Rice seedlings raised in the lowland areas, which could have borne eggs or hatchlings, were also transplanted in the IRT particularly in the upper terraces. GAS was spread all over the IRT through the terrace irrigation system.

The International Rice Research Institute (IRRI) library website (<http://www.ricelib.irri.cgiar.org>) shows some 65 references indicating that GAS research has been concentrated in the lowland areas. As a result, most of the control measures established cannot be applied in the IRT because of its unique characteristics. Current GAS research in cool, elevated areas looks at possible control measures such as the use of indigenous plants as attractants, search

By

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A female golden apple snail can lay about 25-320 strawberry pink eggs at one time. These eggs mature in about 10-15 days

EDITOR'S NOTE

You may well ask why a rice paper in an aquaculture newsletter? "We need a new solution to the old golden apple snail problem, and an integrated approach with fishfarming may be the answer," explains Dr. Ravindra Joshi, a PhilRice research fellow, when he visited SEAFDEC/AQD on January 25. He presents this problem in the hope that researchers on aquaculture may become interested enough to work with him. Dr. Joshi can be reached at: <philrice@silang.slu.edu.ph> or <joshiravi@hotmail.com> Telefax (63-02) 843 5122

for natural predators, modification of water management techniques, development of crop protection practices that can be timed to increase GAS mortality, and discovery of more palatable food recipes for human and animal consumption.

Tracing the origin

Earlier studies conducted by researchers from the University of the Philippines at Los Banos (UPLB) and DA-PhilRice claim that GAS was introduced in the Philippines between 1982 and 1984 from Taiwan, Florida, and Argentina as food and protein source of Filipino farmers. Because of this, GAS was massively cultured and distributed in different lowland areas of the country and now has become one of the major pest problems in rice production.

In Argentina, GAS is not a problem according to Dr. Nestor Cazzaniga of the Universidad Nacional del Sur Departamento de Biología. Although rice is not a staple food in Argentina, large portions of lands are planted to rice because it is exported. Because its production is highly mechanized, fields are properly leveled and water is well-managed and controlled, making it less prone to GAS infestation.

The first report on GAS infestation in the Philippines came out in 1986 when about 300 ha of irrigated lowland rice fields in Region 2 were heavily damaged. In the same year, farmers in the IRT started to notice the same. By 1988, GAS has already damaged about 4% of the country's total rice area and in 1990, the damage reached 11%.

GAS invasion in neighboring countries

A study conducted by Drs. Yoichi Yusa and Takashi Wada of the Kyushu National Agricultural Experiment Station shows that the

➡ next page



Handpicking is still one of the most practical methods in controlling the golden apple snail population



The golden apple snail can damage newly planted rice seedlings overnight

introduction and culture of GAS in Japan started as early as 1964 when a company introduced it as an aquarium pet. It became popular as food in the early 1980s but the production later declined because people did not like the taste of the snail. It was later disposed into rivers, ponds, creeks, and paddies. Damage to rice was reported in 1984 and in the same year, GAS was declared as a quarantine pest by the Ministry of Agriculture, Forestry and Fisheries. Still, aquarium shops in Japan continued to import and sell apple snails as pets. Natural predators currently used include the water birds, fish, turtles, fireworm larvae, and crabs.

In Thailand, it was introduced in 1982 from Japan and Taiwan. Mainly used as decoration in aquariums, GAS rapidly multiplied and eventually produced excess stocks, which were thrown away and reached canals and rivers. The first GAS outbreak was recorded in 1988 south of Bangkok. Several indigenous plants that have been used to control it include the golden dewdrop (*Duranta repens*), mafia nok kum (*Ammannia bacifera*), pla khum dee kwai, and soapberry tree (*Sapindus semarginatus*).

In Vietnam, it was introduced in 1988 from South America and declared as a quarantine pest in 1993. By 1997, it has already spread to 7 out of the 61 provinces. In Nghe

an province, an experiment on the use of fishes such as black amur and tilapia in controlling GAS shows considerable reduction in GAS density to as high as 84% from summer to autumn and 64% from winter to spring.

It was only in 1990 that GAS was first detected in a household tank in Malaysia. Its origin was unknown. Based on the size, it was concluded that GAS had been there for some three to four years earlier. The dispersion of GAS in Malaysia was relatively slow because of the coordinated efforts of relevant authorities. Upon discovery of the GAS, the Department of Agriculture formed the GAS Task Force at the national level. Small working committees were also formed at the district level to monitor the status of infestation and results of control measures employed. In selected areas, effective control measures include the use of salt water, pesticides, snail metal traps, and natural predators such as ducks. An on-going trial on the integration of fish in rice culture has reported promising results.

A year later after GAS was discovered in Malaysia, *Pomacea* sp. was found in a farmer's fishpond in Lao PDR. GAS started to invade neighboring fields when heavy rains flooded the pond causing it to overflow. It was in 1993, when it damaged about 5 ha of rice that it was brought to the atten-

tion of the government.

In 1991, it was introduced in Cambodia through refugees who returned from Thailand. Farmers in Takeo intentionally raised it in their fields as food, just as they normally did with the native snails (*Pila* sp.). Since the native snails do not damage rice, farmers assumed the same for the GAS. One of the most popular attractants used is the dragon bone plant, which is reported to contain toxins.

In Australia, the software package CLIMEX was used in matching the climates of geographical regions where *P. canaliculata* is known to occur with that of other regions in the world. The matching showed that large regions within India, China, and Australia are at risk for future GAS invasion.

Control methods

The GAS are most often found in moist soils with vegetation, commonly in rice paddies. They appear to be very still as they tightly stick to the stems of rice plants and burrow into the clayey soil when soil moisture declines. Their clustered pinkish eggs remain pasted on leaves and stems. Tiny and fragile as they appear, the GAS have high survival rates. An experiment conducted by the group of Joshi demonstrates that GAS can still survive during fallow

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Millennium conference on aquaculture

About 600 people from 72 countries gathered in Bangkok for a NACA and FAO-sponsored aquaculture conference. On February 25, the conference put out a manifesto now known as the "Bangkok Declaration on Aquaculture in the Third Millennium."

While the conference participants recognized that aquaculture has become the fastest growing food-producing sector, they also noted that its potential for easing poverty and securing food supply has not been realized. Further, aquaculture requires fresh, dynamic and responsible strategies if it was to contribute to human development and social empowerment.

So, the Declaration puts forward strategies for aquaculture development beyond 2000 and call on national governments and the private sector to: invest in people through education and training, invest in research and development, improve information flow and communication, improve social and environmental sustainability, integrate aquaculture into rural development, and apply innovations in aquaculture. More specific strategies will be discussed in the final version of the Declaration.

The Bangkok Declaration can not overemphasize the importance of regional cooperation among institutions and agencies in research, extension and training, and information dissemination. It also urged national governments to consider or build on the current FAO Code of Conduct for Responsible Fisheries.

The Declaration was drafted by a committee headed by Glenn Hurry and Chen Foo Yan with Uwe Barg, Pedro Bueno, Jorge Calderon, Jason Clay, Sena De Silva, Maitree Duangsawasdi, Dilip Kumar, Le Thanh Luu, Modadugu Gupta, Joaquin Orrantia, Mike Phillips, Rolando Platon, Vincent Sagua, Sevaly Sen, Patrick Sorgeloos, Rohana Subasinghe, Rolf Willman, Wu and Chao Lin. Much of the technical background of the Declaration is based on consultative expert meetings conducted by NACA and FAO throughout 1999 which was presented in the Bangkok conference.

The Bangkok Declaration is the second of such position papers developed by FAO. The first -- known as the Kyoto Declaration on Aquaculture -- was in 1976. ###



Dr. Rolando Platon with some of the delegates from the Philippines

JIRCAS rep visits AQD

The Director of the Division of Fisheries of the Japan International Research Center for Agricultural Sciences, Dr. Masachika Maeda, visited SEAFDEC/AQD early this year to discuss the possibility of a Memorandum of Understanding between JIRCAS and SEAFDEC. Dr. Maeda (center) was accompanied AQD Deputy Chief Susumu ITO and Mr. Somnuk Pornpatimakorn of the SEAFDEC Secretariat.



JICA experts at SEAFDEC/AQD



Dr. Megumi Minagawa is a JICA short-term expert on mangroves working at AQD from January 25 to February 27. He is presently the Section Chief of the Ishigaki Tropical (Research) Station in Okinawa, Japan.

Dr. Minagawa discussed with AQD researchers the studies conducted at his research institute. For seafarming, studies include determining the ability of corals to absorb nutrients and the

propagation of reef-producing corals. With regards to aquaculture, studies include shrimp diseases and finding their causative environmental factors.

Dr. Minagawa also presented the results of his studies on mudcrab. He said that there are three species of mudcrab in Japan: *Scylla serrata*, *S. olivacea* and *S. paramamosain*. Since morphological identification of juveniles is different, he and his colleagues have developed species identification techniques by DNA analyses. Through this technique, they were able to determine the species composition of the mudcrab population in Okinawa: 99% is *S. serrata*, 1% *S. olivacea*.



Mr. Hideo Mochizuki is working on probiotics in shrimp farming at AQD from January 26 to April 24. Like Dr. Minagawa, he is a JICA expert, and is presently connected with Mitsui Norin Marine Co. Ltd, an aquaculture outfit in Japan. He has previously worked at AQD and BFAR in the 1970s on shrimp production.

Mr. Mochizuki discussed the virtues of using probiotics in the super intensive shrimp farm in Kagoshima, Japan owned by Mitsui Norin. He said that they use CBC-Biozyme which is imported from Taiwan, costing US\$40 per kg.

In their operation, he elaborated, power cost is reduced by 60%, and they attain food conversion ratio (FCR) of 1.8. The use of probiotics has also maintained pH of water in ponds, decreased toxic nitrogen, increased plankton in pond water, increased growth rate, increased survival rate, and improved feed conversion ratio.



Dr. Yasuo Inui, a fish diseases and physiology expert, will start his 2-year tour-of-duty on March 15. He will work with AQD's fish health staff on the prevention of disease epidemics in Southeast Asia. Before this AQD assignment, he was the Director General of Tohoku National Fisheries Research Institute. He also spent time with the Zoology Department of the University of Washington as a Research Associate.

Dr. Inui's project is one of the three that AQD is implementing under the auspices of the ASEAN-SEAFDEC Fisheries Consultative Group. The AQD projects are, in turn, part of the eight that SEAFDEC implements in its technical departments.

Dr. Inui earned his Doctor of Philosophy and Masters in Fisheries Science degrees at the University of Tokyo. His BS Fisheries Science was earned at the Tokyo University of Fisheries.

He has several publications in scientific journals, including: the role of thyroid hormone in tissue development in metamorphosing flounder; cDNA cloning of thyroid hormone receptors B for the flounder; hormonal control of flounder metamorphosis in perspective in comparative endocrinology; effects of bovine TSH on the tissue thyroxine level and metamorphosis in prometamorphic flounder larvae.

Aside from these, Dr. Inui has 50 other papers also published in peer-reviewed international journals.

His job experiences include: assistant (University of Tokyo); researcher (Freshwater Fisheries Research Lab); Section Chief and, later, Director, Pathology Section (National Research Institute of Aquaculture); Coordinator, Research and Planning (Nansei National Fisheries Research Institute); and Director-General (Tohoku National Fisheries Research Institute). ###



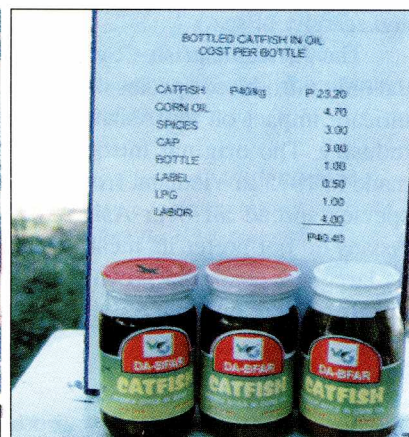
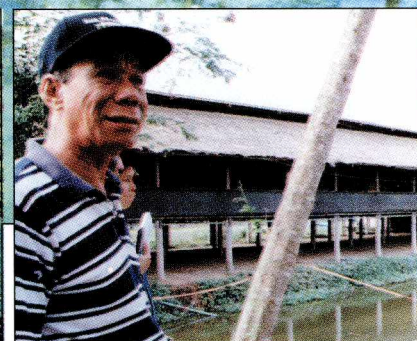
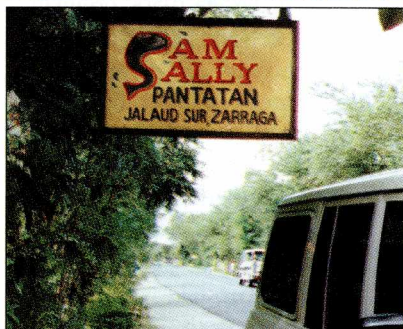
A backyard catfish farm (ABOVE): a business enterprise integrating vegetable and poultry (INSET ON THE LEFT)

Catfish culture

In this issue, we take a look at the catfish industry in Southeast Asia, and interview some catfish farmers in the Philippines. There are considerable efforts by government agencies and regional organizations like SEAFDEC/AQD to develop and promote catfish culture technologies.

Catfish culture is a promising business. But we will let the facts speak for themselves. We hope readers will enjoy and learn from our first issue for the new decade.

Catfish harvest from an earthen pond



Bottled catfish (ABOVE), french style in corn oil, has been developed to appeal to the AB market, thus expand supply and demand. Cost is ₱41 per bottle

Catfish is a popular food fish in Iloilo province. Called pantat, Catfish signs like this (LEFT) dot the northern Iloilo roadsides

Catfish culture in Southeast Asia

By **RIY Adan**

Catfishes rank fifth in the world in terms of fresh and brackish water fish culture, annual production being around 350,000 tons. Catfish farming is monoculture, polyculture, or integrated with rice and livestock.

Although there are over 2,600 species, only three families at present are farmed in any quantity: Ictaluridae, Clariidae and Pangasidae.

In Asia and the Pacific, family Clariidae (*Clarias* spp.) dominates production, representing nearly 80% of the total 76,000 tons catfish produced in 1991. Among the most cultured species are *Clarias batrachus*, *Clarias macrocephalus* and *Clarias gariepinus*.

C. batrachus is the most extensively cultivated species especially in Thailand. It grows fast and is easy to propagate but its meat is not so tender. *C. macrocephalus* on the other hand is preferred for its better taste and tender meat but its culture is not so widespread because of its slow growth and scarcity of seed.

The African catfish *C. gariepinus* is the only introduced species that had a significant impact on the Asian aquaculture industry. The original introduction was made in 1975 in Vietnam, from where the species spread all over Asia. Although Asians do not prefer its meat quality and its large size, its rapid growth and hardiness made it popular among fish farmers.

MARKET

The domestic market generally absorbs catfish produce in Asia, although high producing countries like Thailand and Vietnam engage in export. Freshwater catfish imports for July 1999 in the United States totaled 475,000 pounds, of which 47% came from Vietnam.

There are two basic markets for catfish: live fish and processed fish. Live fish commands a higher price as compared to the processed form such as fillet. Consumer

preference also dictates the price of certain species. Off-flavor and fatty fish are the major problems in product quality control. Catfish has a "poor image" especially in coastal communities and thus has low acceptance.

In general, the catfish farming industry is still young and growing; but unfortunately, already faced with problems arising from declining availability and increasing price of trash fish and other animal feed ingredients, erratic feed management, and diseases. But improvements are already being studied, such as in culture techniques (induced breeding and nursing, health management, pond management) and in feed formulation and manufacturing.

TOP THREE CATFISH-PRODUCING COUNTRIES

Thailand

The Thai catfishes are locally known as pla duk. There are five species, of which only two are popular: pla duk dan or *C. batrachus* and pla duk oui or *C. macrocephalus*. Both are widely distributed in all types of freshwater bodies. Both are also popular food fishes and command high market prices.

Most of the clariid catfishes in Thailand are cultured in ponds. But about 5% of production reportedly comes from fish culture in rice fields and ditches.

The culture of *Clarias* in Thailand began in the late 1950s, originally in the Bangkok area and later in central Thailand. The country has developed a highly intensive culture for clariids that has since served as a model for other countries in Southeast Asia.

Catfish culture gives a higher annual income than other forms of agriculture. However, their natural habitats are being reduced by industrialization and their availability is declining rapidly.

In 1987, *Clarias gariepinus* was introduced from neighboring Laos. The Department of Fisheries encouraged farmers to raise this species because of its better quality, quicker growth, and improved resistance to diseases. Moreover, *C. gariepinus* can reach 200-250 g average body weight in 3 months and has much better survival rates than the indigenous species.

When *C. gariepinus* and *C. macrocephalus* were successfully interbred, the industry shifted to this hybrid which has enhanced characteristics of both species. In 1997, production reached 52,680 ton worth US\$43,615,000, making Thailand the highest producing country of catfish in Southeast Asia (see table). Most of the catfishes are marketed live.

Indonesia

Indonesia ranks first in Southeast Asia in terms of freshwater production (0.3 million tons in 1995) and catfish is one of the cultured species. *C. batrachus* is native to Sumatra, Java and Kalimantan; however, it was introduced to Sulawesi and Irian Jaya.

Government agencies actively promoted the adoption of induced breeding and intensive pond culture of catfish since the early 1980s, but until the second half of the decade, production of *Clarias* remained below 1,000 tons or 0.5% of the volume of freshwater fish culture. The major constraints were the limited supply of fry and traditional culture techniques which had low profitability.

With the introduction of *C. gariepinus* in mid-1980s and the development of a hybrid (*C. gariepinus* x *C. batrachus*), cultured catfish production reached 4,000 tons in 1991. In 1997, *Clarias* spp. production rose to 12,900 tons.

Malaysia

The culture of catfish in Malaysia is lim-

Catfish production in Southeast Asia and some part of the the Middle East, 1984 - 1997 (courtesy of FAO DataBank)

BY VOLUME (tons)

	Species	1984	1986	1988	1990	1992	1994	1996	1997
Brunei Darussalam	<i>Clarias</i> spp.	--	--	--	--	2	1	<0.5	<0.5
Cambodia	<i>C. batrachus</i>	60	80	170	235	310	280	330	420
	Siluroidei	80	95	200	280	370	330	390	500
China, Hong Kong SAR	<i>C. fuscus</i>	130	110	140	120	110	374	<0.5	0
India	<i>Clarias</i> spp.	--	36,000	36,500	39,260	50,323	50,000	85,127	91,163
Indonesia	<i>Clarias</i> spp.	692	886	2,500	3,739	6,330	9,786	15,627	12,900
Korea	<i>Ictalurus</i>	--	--	--	--	--	--	998	--
	Siluroidei	--	--	--	--	--	1,615	2,206	2,995
Malaysia	<i>Clarias</i> spp.	--	--	183	197	904	827	1,379	4,177
Philippines	<i>Clarias</i> spp.	86	143	100	--	--	2,028	1,075	1,053
Saudi Arabia	<i>C. gariepinus</i>	0	0	0	0	0	0	20	23
Syrian Arab Republic	<i>C. gariepinus</i>	0	0	0	0	0	0	65	45
Taiwan	<i>Clarias</i> spp.	349	58	48	40	69	933	283	196
Thailand	<i>C. gariepinus</i> x <i>C. macrocephalus</i>	4,598	15,817	12,551	17,900	23,775	34,170	47,711	52,680

BY VALUE (x US\$1,000)

	Species	1984	1990	1996	1997
Brunei Darussalam	<i>Clarias</i> spp.	--	--	<0.5	<0.5
Cambodia	<i>C. batrachus</i>	90	423	693	798
	Siluroidei	96	672	916	1,150
China, Hong Kong SAR	<i>C. fuscus</i>	402	324	<0.5	0
India	<i>Clarias</i> spp.	--	78,553	85,127	91,163
Indonesia	<i>Clarias</i> spp.	692	9,348	38,286	32,250
Korea	<i>Ictalurus</i>	--	--	1,697	--
	Siluroidei	--	--	15.00	8,237
Malaysia	<i>Clarias</i> spp.	--	280	1,924	5,227
Philippines	<i>Clarias</i> spp.	93	--	2,078	1,582
Saudi Arabia	<i>C. gariepinus</i>	0	0	56	64
Syrian Arab Republic	<i>C. gariepinus</i>	0	0	358	252
Taiwan	<i>Clarias</i> spp.	459	90	1,184	380
Thailand	<i>C. gariepinus</i> x <i>C. macrocephalus</i>	5,552	18,905	47,029	43,616

ited exclusively to freshwater catfishes, among the most popular are keli kayu (walking catfish) or *C. batrachus*, the keli bunga or *C. macrocephalus* and the keli africa or *C. gariepinus*.

Catfish culture began in the early 1960s with the small-scale culture of keli kayu, mostly small-scale and involving the fattening of stock produced from rice growing areas. Production reached its peak in early 1970s but in early 1980s, production declined due to disease problems. However, the industry was revived in the mid-1980s

when *Clarias macrocephalus* fry was successfully produced by the Freshwater Fish Research Center in Batu Berendam.

At about the same time, *C. gariepinus* became popular. This exotic catfish was a fast grower, highly resistant to diseases and readily accepted by the local people. The African catfish, however, could not match the demand or preference by local consumers for their local species. The African catfish retailed for about RM 4 per kg as compared with the *C. batrachus* and *C. macrocephalus*, both of which commanded market prices in the region of RM 6 per kg.

Most of the *Clarias* currently cultured in Malaysia is of the hybrid type (*C. macrocephalus* x *C. gariepinus*). The hybrid resembles the local catfish, which is readily accepted by the consumers and fetches a better price. Production in 1988 was only 183 ton but in 1997 it reached 4,177 tons. This increase was attributed to the improved technique of culture with the utilization of formulated floating pellet feed.

Most of the catfish produced is marketed live locally. However, significant quantities are also exported live to Singapore, Hongkong and Taiwan. *Clarias* is rarely marketed in processed or semi-processed form. At the moment, processed catfish meat receives little attention mainly because there is no surplus to be processed.

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SEAFDEC/AQD's catfish hatchery specialist at work

By **NJ Dagoon**

SEAFDEC/AQD scientist Dr. Josefa Tan-Fermin started work on the native catfish *Clarias macrocephalus* in the late 1980s. She gathered broodstock in 1988 then developed a simple but effective way of inducing catfish to spawn. In 1989-1990, Dr. Fermin and her team determined the optimum hormone dose and best time to strip the eggs by taking samples of eggs from the ovary of injected fish. They measured the size and monitored the maturation stages of the eggs under the microscope every 3 hours for 24 h in

several runs. Information on the optimum hormone dose and time of stripping of the female is a prerequisite to ensure the success of the artificial propagation program especially of species that do not spawn naturally.

Popular spawning agents in fishes include pituitary glands, human chorionic gonadotropin (HCG), and the luteinizing hormone releasing hormone (LHRH). Pituitary glands are less expensive but dissection of the organs in fish requires skill and practice. Furthermore, it is difficult to quantify the amount of gonadotrophin (GTH, a hormone in the pituitary gland that is mainly responsible for reproduction) because GTH content varies with age, size and stage of maturity of the fish. HCG is expensive and is a large protein molecule. Its prolonged use is reported to develop antibodies in fish. LHRH, a small molecule of about 10 amino acids, induces the pituitary gland to secrete GTH. LHRH however, is sometimes not effective when used

alone especially in fishes containing high levels of dopamine, which inhibit the release of GTH.

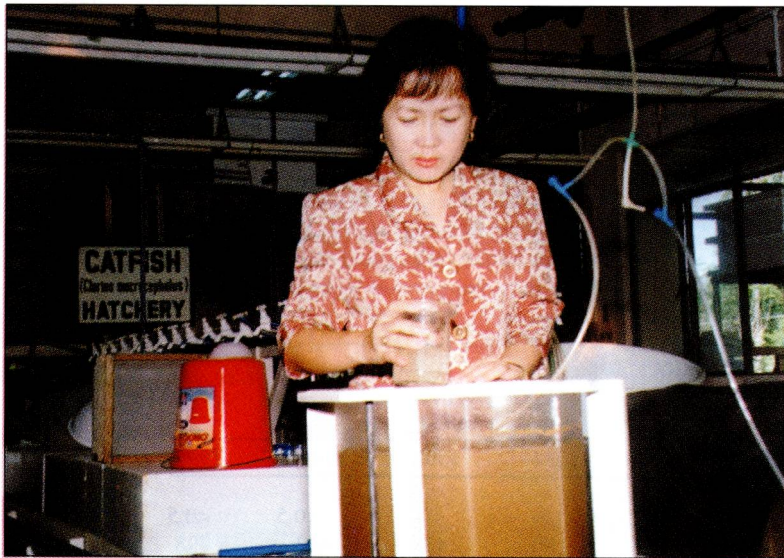
Different workers were using the combination of LHRH with dopamine antagonists such as pimozide or domperidone to spawn various fishes including other *Clarias* species like *C. gariepinus* and *C. batrachus*, following the LinPe method (after the authors Professors Lin of the People's Republic of China and Peter of Canada). So, Dr. Fermin also tried this hormone combination on *C. macrocephalus*. Pimozide cannot be dissolved in the usual solvents used by other workers. Since the suspension of pimozide clogged the needles, Dr. Fermin tried different solvents in which pimozide was completely dissolved. As a consequence, a lower dose of pimozide in combination with LHRH is used in *C. macrocephalus*. Based on the LinPe method also, several companies have developed spawning agents that incorporated gonadotropin hormone releasing hor-

mone (has the same action as LHRH) and a dopamine antagonist in one single solution. Dr. Fermin has also tried Ovaprim and Ovatide, products of Syndel Pharmaceuticals in Canada and Hemmo Pharma in India, respectively.

Aside from her work on catfish, Dr. Fermin was then pursuing sex change research on grouper. She applied for doctoral studies at the Faculty of Fisheries, Hokkaido University in Japan in the laboratory of Prof. Kohei Yamauchi who advised her to concentrate on cat-

fish for dissertation. The laboratory of Prof. Yamauchi specializes on reproductive physiology and endocrinology of freshwater fishes. Home adviser Dr. Clarissa Marte, SEAFDEC/AQD research head, further advised Dr. Fermin to focus on the later stages of maturation, which is the constraint in the propagation of *C. macrocephalus*.

In the early 1990s, several projects, including "Broodstock development and seed production of *C. macrocephalus*," got funding from the Fisheries Sector Program (FSP) of the Department of Agriculture-Bureau of Agricultural Research (DABAR). Other researchers in the Research Division got involved in the implementation of the project. Dr. Luis Ma. Garcia tried hormones and pheromones on catfish breeders to induce the spontaneous release of eggs and milt (a hydrated suspension of sperm). Dr. Fermin tested several methods that can improve the hatching efficiency of the catfish eggs. Mr. Armando



Dr. Josefa Tan-Fermin, SEAFDEC catfish hatchery specialist, examines newly hatched Artemia, catfish larvae food

Fermin did refinement of hatchery and nursery techniques to mass produce the fry. In addition, Dr. Corazon Santiago's study on the development of broodstock diet for *C. macrocephalus* was also funded by FSP.

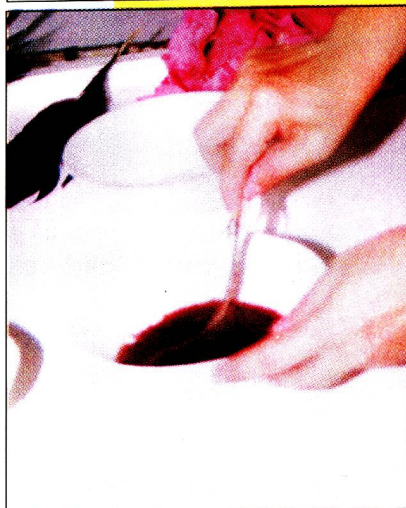
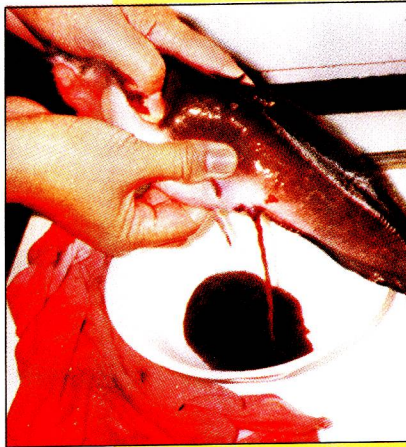
Dr. Fermin's dissertation showed that there is a best time to induce the breeding of catfish. Although catfish can be induced to spawn whole year round, reproductive and larval performances are relatively inferior when spawning runs are carried out during the months of January to March in the Philippines.

One of the main constraints in the artificial propagation of *C. macrocephalus* is the practice of sacrificing males to obtain the milt in fertilizing eggs. Dr. Fermin tried to solve this problem by testing several hormonal treatments that will induce the milt release of male catfish. As in the results of the FSP-funded study of Dr. Garcia, spontaneous or manual release of milt was not observed. In previous reports, catfish milt was usually suspended in saline solution, and one male was sacrificed to fertilize the eggs from one female. Although Dr. Fermin found out that sacrificing catfish males was inevitable, she saw an efficient way of maximizing the use of milt. By dilution of and adding a lower saline concentration to the milt, one male is enough to fertilize the eggs from 3-4 females.

In 1998, Dr. Fermin tried putting all the best results of her experiments into one study to verify the breeding and hatchery protocol developed at AQD for catfish that can be widely adopted by the private industry. When Mr. Fermin started to work on abalone and later became the project leader, there

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SEAFDEC/AQD's induced maturation and breeding protocol



Acclimation

Catfish broodstock can feed on formulated diet of 36% protein. During induced spawning runs, sexually mature male and female fish are taken in the morning from broodstock tanks and stocked separately in smaller tanks. The body weights of each female fish are recorded prior to stocking.

Hormone preparation

Different hormones such as luteinizing hormone releasing hormone analogue (LHRHa) + pimozone (PIM), human chorionic gonadotropin (hCG), pituitary gland extract (PG), Ovaprim (Syndel Pharmaceuticals, Canada), Ovotide (Hemmo Pharma, India) etc. are used to spawn the female catfish. Hormones are prepared just before females are injected, and the remaining solution is kept in a sealed vial inside the refrigerator.

Injection

Gravid females are injected with any of the hormones in the afternoon, between 2 to 5 PM. Hormones are injected into the dorsal musculature of the fish.

Artificial fertilization

The next morning, about 16 to 20 hours after hormone injection, ovulated eggs are manually stripped from the females by squeezing the lower abdomen. Just before females are stripped of eggs, male catfish are sacrificed to get the reproductive tract that is then macerated and crushed to obtain milt, the hydrated suspension of sperm. Catfish milt is suspended in saline solution and the milt-saline mixture is poured into the basin that holds the stripped eggs also. Milt from one male can fertilize eggs from three females that are of the same body weight. Ovulated eggs are mixed with the diluted milt with a dry feather for about 1-2 minutes. Few drops of water from the faucet are added to the egg-milt, with continuous stirring. The fertilized egg mass is then transferred to a small scoop net, washed gently with

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SEAFDEC/AQD and the Provincial Government of Iloilo in catfish reseedling project



LARRY LOCARA

GINGGING LOPEZ



AQD research head Dr. Clarissa Marte (center) signs the catfish reseedling agreement with Iloilo Governor Arthur Defensor



Reseeding of Tigum River, Maasin, Iloilo with native catfish (*Clarias macrocephalus*) bred at SEAFDEC/AQD, September 4, 1999

In a province-wide campaign, the Iloilo Provincial Government (IPG) and SEAFDEC/AQD are collaborating to bring back the native catfish (*Clarias macrocephalus*) to its farms and rivers, to conserve its local biodiversity.

The native catfish, known locally as pantat or hito used to be so abundant in rice farms but slowly disappeared when the high yielding varieties (HYVs) of rice strains were introduced to Iloilo's farms. With its heavy pesticides input, it was believed that the run-off water from rice farms flowed into rivers and streams and poisoned the natural spawning grounds of the pantat. Another factor in the disappearance of the native pantat was the introduction of the African variety (*C. gariepinus*) and the Thailand variety (*C. batrachus*) which crowded out the native species. Both were perceived to be impervious to pesticide pollution and were fast growers. But a shift to integrated pest management (IPM) in rice farming which eschews the use of pesticides encouraged farmers to culture fish in rice farms.

It is high time that the native pantat stage a comeback. After all, local consumers prefer it against the foreign species. The native pantat is reported to be more succulent and delicious. It also

commands a higher price than the imports -- P150.00 per kg, P60 higher than the African species, hence, it is being promoted as an alternative source of income.

In September last year, AQD and the Iloilo Provincial Government signed an agreement to collaborate on bringing back the native catfish to Iloilo farms and rivers. The signing was held simultaneously with a ceremonial reseedling of native catfish along Tigum river in Maasin Iloilo, about 30 km northwest of Iloilo City.

As part of the agreement, AQD conducted a two-week training course on seed production of native catfish at its headquarters in Tigbauan, Iloilo. The training was attended by six technical personnel of the provincial government who will be involved in the implementation of the program. Aside from the six, two participants from the private sector availed of the hands on training on breeding and nursery management of catfish developed by AQD.

Other rivers to be reseeded with catfish are: Jalaur river, which traverses Lambunao and Barotac Nuevo; Suague river which also traverses Janiway and Barotac Nuevo and Asul river which traverses Sara and Ajuy. -- AP Surtida

Sally's protocol

By **AP Surtida**

Zarraga is a fifth-class municipality about 16 km northeast of Iloilo City. African catfish is extremely popular here. Hatcheries, backyard ponds and catfish hawkers along the highway are familiar sights and are almost everywhere. That's why it has earned its sobriquet the "African catfish center" of Iloilo.

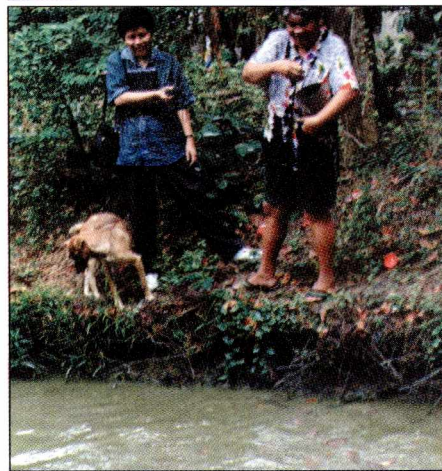
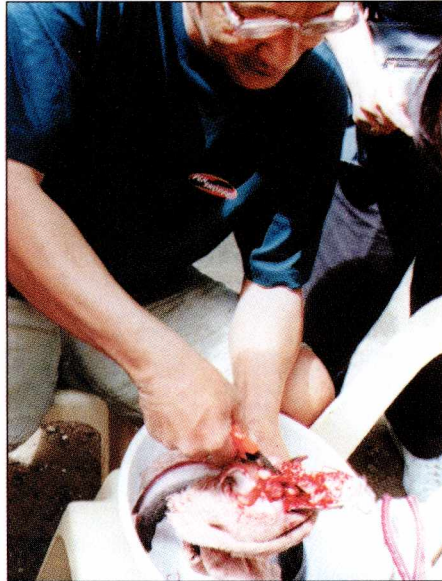
We managed to talk to one of the backyard hatchery owners here -- the Caspillo couple, who runs the Sam Sally Pantatan in Jalaud Sur, Zarraga. Samuel and Sally are a homey couple who run their hatchery in a "mom and pop" business manner. They averred that business is good, and were able to send their children to college with the help of their hatchery. Sam volunteered to demonstrate to us how to extract the pituitary gland of a male catfish which our photographer ably documented.

Sally described the step-by-step protocol she observes in induced spawning the African catfish. According to Sally, her method is a sum total of her hatchery experience, literature reading, exchange of shop-talk with fellow hatchery owners, and other sources of information.

Here is Sally's protocol:

- *Get the breeders.* Sally has a broodstock pond in her backyard with around 80 female and a few male breeders
- *Sort the gravid females and select.* She spots the mature females by its swollen belly and greenish brown color. The green colored ones are immature, according to Sally. The female should weigh about 1 kg
- *Select the male and put in a separate tub.* The male should weigh about 1.5 kg. (The donor male of the pituitary gland which was killed previously)

Another donor male will be used for his testes, the weight should be the same ratio: 1.5 kg male to 1 kg female



- *Macerate the pituitary gland previously taken from another male and preserve in acetone solution.* The macerated pituitary gland is mixed with 1-2 ml of distilled water to become a suspension for easy injection
- *With a syringe, inject the pituitary suspension in the dorsal muscles or the back of the female catfish*
- *Return female catfish to holding tank with water and wait for at least 12 hours.* (Sally usually does the injecting at night for convenience.) Wait until the female is ready to shed off the eggs
- *Get the male catfish, open the stomach, get the testes.* Sally said males need not be killed, stomach can be sewed-up and the fish returned to the pond
- *Macerate the testes, mix with saline solution (0.9% salt in distilled water)*
- *Strip the female of its eggs, then mix these with the macerated testes in a bowl or basin*
- *Shake the basin gently, put the (fertilized) eggs into a tub with hapa net to be aerated overnight.* Wait for another 24-48 hours for the eggs to hatch

Sally said the African catfish will yield about 17,000-20,000 eggs per fish while the native *Clarias macrocephalus* will yield about 3,000-5,000 per fish. In about 20-25 days, the fingerlings are ready to be sold.

Sally said she sells fingerlings (about 1.5-2 inches) at P2 apiece. The Bureau of Fisheries and Aquatic Resources (BFAR) is one of her biggest buyers which gets about 40,000 fry.

Sam Caspillo demonstrates pituitary gland extraction (top); Sally's broodstock pond (middle); and Sally Caspillo describes her protocol (bottom)

Growing catfish in the Philippines

By **MB Surtida** and **RY Buendia**

Catfish (*Clarias macrocephalus*) is indigenous in Philippine waters, thus, Filipinos are familiar with it as a food fish and a lot consider its taste as excellent. But as with most indigenous food species that are constantly extracted, our native Philippine catfish, locally called *native* or *hitong tagalog* can no longer be found in abundance.

Today, the imported African catfish (*C. gariepinus*) is more abundant. Filipinos have readily accepted it perhaps because of their familiarity with the native catfish. Most catfish eaters say that the two species taste the same and dealers pass the African catfish as *native* to encourage hesitant buyers. Few people know that our native catfish do not grow as large as the African and that catfish in the markets are seldom *native* as these are not grown in commercial quantity. Production of the African catfish, however, is low and its market remains undeveloped. This article describes the catfish industry in the Philippines and will refer to the African catfish *C. gariepinus* unless otherwise stated.

Small catfish farms

Most small catfish farms measure less than 1000 m². Production does not exceed 500 kg per week. The farms in the province of Iloilo, west central Philippines are usually integrated with vegetables and are not the main source of income.

Charlie Guardapes is the technician of an integrated farm within a residential subdivision. The farm area is 1,700 m², and is planted to several kinds of high value vegetables. There are two catfish ponds 18 m² each.

Charlie stocks 100 fingerlings and harvests every 2-3 months. His last catfish harvest was 25 kg sold at P80 per kg. He grows lettuce, green onions, ampalaya, pepper leaves, and pechay. He also grows swamp cabbage (kangkong) in his tilapia



ponds. For his vegetable plots, he uses tilapia pond water. He swears to an improved harvest compared to when he still wasn't using tilapia water. His earnings from his integrated farm allows him to support his family of five. Incidentally, this small integrated farm serves as a model farm of the Iloilo provincial government to promote sustainable farming and maximization of land use.

Arsenio "Nonoy" Suoribio has two



The Guardapes catfish ponds are ensconced in high value vegetable plots in a 1,700 m² residential area. Both commodities give sufficient income to support a family of five

250 m², two 135 m² and one 50 m² ponds stocked with catfish in Sta. Barbara, Iloilo. His ponds lie side by side and are equipped with an underground drainage. He harvests 500 kg per week from two ponds. His water supply comes from a deep well, and he changes pond water weekly. He stocks at 15 fish per m². Feeding is done twice daily at 3% body mass with a commercial feed. But he uses swine pellets instead of aquaculture feed because "it is cheaper." A 25 kg bag of pellets for fish costs P500 while that for swine is also P500 but contains 50 kg, and his catfish devour the swine pellets as they would the fish pellets.

Nonoy harvests his stock (partial) after 75 days, selling 150-200 g fish. Depending on customer preference, he harvests bigger sizes (200-250 g). His retail price (he sells to neighboring homes on his motorcycle) is P80 per kg and wholesale at P50 per kg. During peak months, orders exceed his production but he buys from nearby ponds to fill in orders. He makes sure though that the catfish that he buys is of the same quality as his.

Source of fingerlings is not a problem as hatcheries from other towns can now supply his needs. His customers repeatedly order from him because he claims, "they

RIGHT *The Locara brothers plant kangkong (swamp cabbage) in their catfish ponds to avoid frequent water change as the planted kangkong act as biofilter.*

BELOW *In the province of Bulacan, large catfish farms can produce 2 tons per week and supply 70% of the Philippine catfish market*



like the aroma and taste of my catfish." Sometimes, people complain of foul smell in catfish meat. But not his catfish, Nonoy says, perhaps because his culture water is clean and he doesn't feed with chicken entrails and raw golden snail meat as others in the area do.

The Locara Farm (owned by brothers Joemarie and Larry) in Dingle, Iloilo has two 230 m² catfish ponds with pond dikes planted to different vegetables. His water source is a 1-m deep well, and water change is done weekly. He stocks 5-7 fingerlings per m². When the fingerlings are small, he feeds them commercial feed at 1% body mass per day. As the fish become bigger, he feeds them with golden snail meat (kuhol). Larry says that he also plants swamp cabbage in his catfish ponds as he thinks they act as biofilter. He also adds a few tilapia to the catfish stock. He says that without the swamp cabbage and tilapia, he would have to change his pond water more frequently. After 3 months or when his catfish reach 200 g, he sells them at P65 per kg. His buyers are usually from neighboring towns and barangays.

Larry says that catfish is easy to grow because they can eat unprocessed feed [with his foot, he crushes the snail (kuhol) and

broadcasts the meat in the pond], not easily affected by diseases, and pond preparation is not complicated. In pond preparation, he only gets rid of predators while the catfish are small, and when these get bigger, they are almost left alone to fend for themselves except for the daily feeding ritual. But even then, if one forgets to feed twice for one or two days, the fish are not affected. They would still sell at the usual price.

The big farms

The Augru Integrated Farm in Bilidan, New Lucena, Iloilo is operated by Rufino Suelo. He started raising catfish in 1996 in a 2,000 m² and eight 350 m² ponds. Production capacity of all his ponds is 1 ton a week. He stocks at 10 fish per m² and changes water weekly. He buys fingerlings from known dealers at P2 per piece. With the catfish, he raises chicken broilers for a company on a contract farming arrangement. From his chicken farm which lies beside two of his ponds, he gets chicken entrails which he processes to feed his catfish. He says he has his own pelletizing machine and processes his own feed. He also buys trash fish for feed when it is available. His production capacity is 1 ton a week and adds that Iloilo's market demand for catfish is 5 tons a week.

"There is room for many more catfish producers. Catfish used to sell very well but with more people going into catfish pro-

duction, prices have dipped," he says. He has not fully stocked his ponds because he says that profit would be affected by the low market price. Another problem is the continuous erosion of his dikes because he says that catfish burrow in the dike bottom, rendering it soft. The top portion of the dike slowly collapses. But he is hesitant to cement his ponds because when catfish burrow, he says, they hit the cemented wall and hurt their mouth. They are then unable to eat.

According to Rolando Ramos, owner of a commercial catfish farm in Pandi, Bulacan, Bulacan is the biggest catfish producing province in Northern Luzon (other towns are Calumpit and Bustos). In Pandi, 25% of farmers culture catfish and their market reach Ilocos, Isabela, Pangasinan, Tarlac, and Pampanga, all provinces in north Luzon. Bulk orders usually come from Pampanga province at 2 tons in one night. One hundred individual farms operate in Pandi. His hatchery-produced fry are transported as far as the Bicol region.

Skewered broiled catfish are ubiquitously sold along the highway through the provinces of Pangasinan, Pampanga, and Bulacan. Thus, most people believe that these provinces produce the catfish that are sold within their province. That is not true. Interviews with broiled catfish retailers say that their supply comes from Bulacan. Marketplace retailers in Bayambang and Bautista, two Pangasinan towns that retail catfish everyday attest to this source.

Ramos says that growing catfish is simple as he has been farming catfish since 1989. He started with a few small ponds (sizes 200-500 m²) adding more ponds as he made profit. Although small and in varying sizes, he now has 16 ponds totalling more than a hectare. He doesn't do much to prepare his ponds. After emptying a pond, for example, he stocks again after about 1 or 2 weeks. He doesn't treat predators as they rarely affect his stock.

He stocks 15 fingerlings per m². He says, "for 15,000 fry that I stock, I harvest about 1.5 to 2 tons after 80-90 days." When

next page



Laureano Marquez owns one of the big catfish farms in Pandi, Bulacan and uses swine pellets instead of aquaculture feeds



Ex-councilor Rolando Ramos harvests 2 tons each week from his catfish farm and thinks highly of the bright future of the catfish industry. If he had more resources, he would certainly expand his production as present supply is hardly able to cope with demand. He says that if he can produce 5 tons a week, it would still sell as briskly as his present production



Skewered catfish are sold cooked in roadsides along Northern Luzon mainly in Pangasinan province



fingerlings are small, he feeds them twice daily and when they get to be about 5 inches long, he feeds daily. But his daily feedings do not consist of aquaculture feeds (floaters) only. His main feed is chopped trash fish (*galunggong*, round scad) or chicken entrails (large intestines). He doesn't cook them as he claims that they are fresh and delivered to him daily from a nearby chicken farm and trashfish dealer.

Ramos changes his pond water as frequently as he can (3-4 times a week) because his ponds lie adjacent to an irrigation canal. Thus, while pumping, water in the irrigation canal gets to his ponds first, and empties to the nearby ricefields. He claims that the rice (he also owns a small parcel of rice field) grow very well as he feels that the leftover feeds become fertilizer for the rice.

Sometimes when the weather gets too cold, mortality occurs. The biggest mortality he has experienced was 20%. With this mortality, he still gets a good profit. For every kilogram he sells, production cost ranges from P15-P20 a kg to cover cost of fingerlings and feeds. Farmgate price is P52 for orders more than 1 ton and P60 for less

than 1 ton. Retail price is P70-80 a kg.

Diseases also occur. The most usual are whitening of the snout and skin sores. To prevent the disease from spreading, he treats his pond water with methylene blue and salt. Salt is placed in the pond water (enough to make water salty). Almost always, the catfish get better and minimal mortality occurs, if at all.

Ramos has 2,000 breeders that supply fingerlings to his and adjacent farm needs. At present, he sells fry (2-4 cm) at P1 each. Since he started breeding in 1990, he doesn't worry about availability of fry and high cost. "It used to cost P3 per fry when there were no hatcheries in Bulacan," he says. "Now with so many hatcheries operating, fry cost has considerably decreased. Bicol region, he says, has catfish farms but production costs is higher because few produce catfish. "People are just learning to like catfish there," he says.

Laureano Marquez also has a catfish farm in Pandi, Bulacan. Like Ramos, his ponds vary in sizes (12 ponds) to total about one hectare. He also started with a few ponds in 1996 and gradually expanded. As townmates, Ramos and Marquez use the

same protocol for grow-out except that Marquez doesn't have a hatchery. He buys his fingerlings at P1 apiece. He feeds with trash fish and pellets but pellets are his main feed. He uses swine pellets instead of fish pellets because it is cheaper (similar to Suoribio's small farm operation).

He changes water twice weekly to avoid diseases. He says that catfish are prone to infection when water is not changed frequently. He identifies diseases similar to Ramos but adds one more: reddening of the head. When disease occurs, he treats his 200 m² pond with methylene blue and 1 sack salt (for 1 m water depth) or 1 pail salt (for 1 ft water depth).

Marquez says that harvest for 30,000 fingerlings reach as high as 6 tons on good days (not unlike the production of Ramos). "In three years, I have had only three good harvests. All my other productions are only half that amount," he says. He attributes his unsatisfactory harvests to not having a hatchery. He said he spends more, thus, he gets lesser profit, compared to those who own hatcheries.

His buyers are from the Ilocos and Pampanga provinces. ☛ page 33

From the ponds to the supermarket shelves

By **MB Surtida** and **RY Buendia**

Bottled catfish frenchstyle in corn oil? It can be a feast. The process is simple and short, from the harvest until they are ready for the supermarket shelves.

The process

From the farm, render the catfish (200-300 g each) lifeless with sprinkling of salt; skin it by using forceps; wash and then cut according to bottle height (8 oz); soak for 10 min in 10% salt solution; dry in oven (1 hr) or sundry (3 hr); fry in oil, 2 min; pack tightly in bottles to include spices -- 1 slice each pickles and carrots, 1/2 bayleaf, 3 granules whole black pepper, 2 small pcs hot chili pepper, 1 pinch msg; pour corn oil to neck of bottle; seal bottle tightly; cook in pressure cooker (10 lb/in²) for 90 minutes; allow pressure to decrease and open at 0 pressure. Shelf life is one year.

Where to learn

The above process has been developed by the Bureau of Fisheries and Aquatic Resources - National Integrated Fisheries Technology and Development Center (BFAR-NIFTDC) in Binloc, Bonuan, Dagupan City. Center Officer in-Charge Westly Rosario says that bottling catfish french style in corn oil is one way of penetrating the AB market. "These people do not like to handle live fish, they want fish in meat form," he says.

Rosario says that the bottling technology can now be picked up by investors for mass production. When requested, the office conducts training for catfish production from breeding to processing, although filleting and freezing methodologies are still being developed. "Processing can expand the present catfish market which is controlled by very few middle men who know where production operations are. Production would also expand, and, hopefully be available to more consumers," he says.

His office crossbreeds male *C. macrocephalus* (native or hitong tagalog) and female *C. gariepinus* (African). The cross breeding study would hopefully improve the growth rate (*C. macrocephalus* reach market size in 7-8 months while *C. gariepinus*, 2-3 months), aroma, and meat quality. The crossbreeding study, started in 1999 has now produced 6-in long catfish. *C. macrocephalus* breeders, now very difficult to obtain, is from Baler, Quezon.

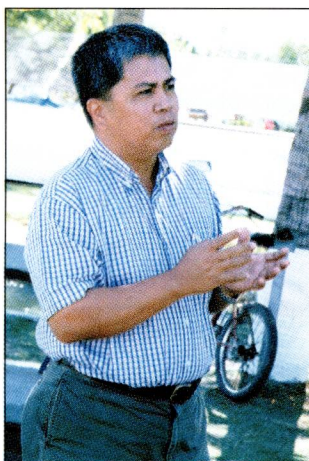
Crossbred catfish, now in market sizes are being monitored for growth rate, aroma acceptability, and meat quality



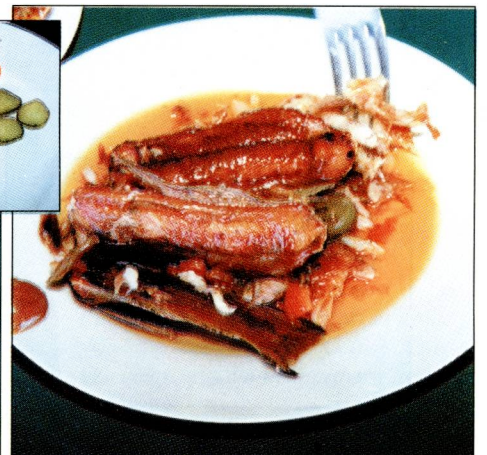
Catfish meat, cut according to bottle height are skinned and soaked in brine solution (10%) for 6 minutes, fried and packed with condiments and corn oil

Condiments and bottled catfish ready for serving. Exposure to pressure cooking is 90 minutes to soften the thick mid bone of the catfish

Westly
Rosario,
Officer-in-
Charge of
NIFTDC in
Dagupan
City
crossbreeds
male native
with female
African
catfish

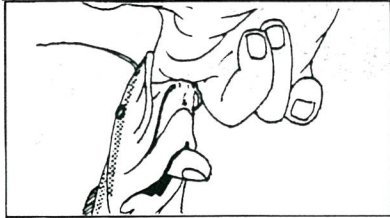


These bottled catfish can now be produced by interested entrepreneurs

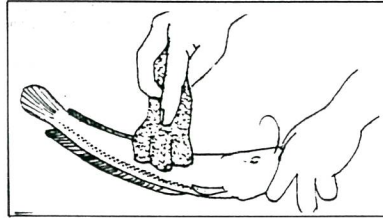


How to dress a catfish

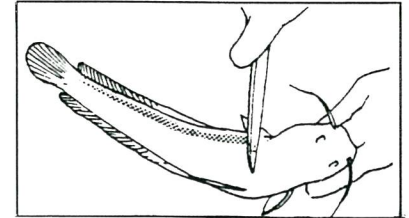
Mr. Lorenzo Locara* demonstrated a quick and convenient way of handling catfish before cooking. His method is efficient and danger-proof against the catfish fins at the sides which are extremely painful when one gets pricked. Here is Larry's method:



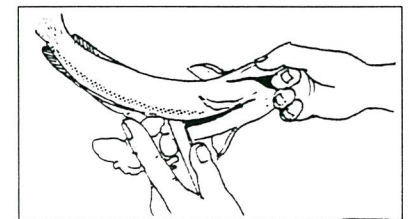
- 1** Insert forefinger into the mouth of catfish. Don't get scared. It won't bite. Get a good grip of the fish. Holding it in the mouth gives you more control against the fish movement



- 2** With a scrubbing pad or leaves of banana or guava, scrub the catfish thoroughly to rid it of the slime



- 3** With a knife's edge, again scrub it thoroughly to get rid of remaining slime



- 4** Eviscerate the fish. Take out the internal organs, including the gills. Wash thoroughly

a sample recipe

Catfish in coconut milk

Ingredients

Cleaned catfish
Young "gabi" leaves
Coconut milk, fresh
Spices: garlic, onion, long chili pepper, lemon grass, "batuan"
Anatto juice
Vinegar
Salt and pepper to taste

Clean catfish. Slice according to desired sizes. Place in cooking utensil with young gabi leaves, anatto juice and spices. Add vinegar and allow to boil for 5 minutes. Pour in coconut milk. Let boil for another 10-15 minutes. Season to taste. Serve hot.



RECIPE COURTESY OF JOEMARI LOCARA

*Project Evaluation Officer and Chief of Research and Evaluation Office of the Iloilo Provincial Government

Marketing of catfish in Iloilo

By **Lorenzo Locara**

Office of the Iloilo Provincial Government
Iloilo City

Although tasty and distinct, *Clarias* spp. had always been considered a minor fish in Iloilo. Compared to tilapia and milkfish, its marketing remains specialized. Historically, its consumption was limited to those who had acquired a taste for it due largely to folklore that it came out of cemeteries and its propensity to feed on animals floating on waters and ponds.

The traditional market of catfish is the Zarraga municipality, 15 km north of Iloilo City, where catfish are hawked along the road in front of the municipal road, mostly to motorists and passengers of public transport. Catfish was not farmed until the early 1990s.

The endemic *Clarias macrocephalus* has disappeared from the market, maybe due to pesticide poisoning, loss of breeding habitat and overfishing (especially the use of electric rod which can stun the adult but kill juveniles). *C. batrachus* was introduced in the early 1980s and had established itself in the province but its tough, rubbery and yellow-colored meat was not accepted by catfish eaters.

The introduction of African catfish *C. gariepinus* in the early 1990s, helped revive the dying catfish industry. It also helped farmers of Zarraga survive the worst of El Nino in 1997 when rice farming was not possible. While decades before, catfish (mostly *C. macrocephalus*) supply from the wild was erratic, farmed *C. gariepinus* is now a daily offering. Small farmers growing the fish in ponds as small as 20 m² deliver their produce to hawkers when the fish weigh 200 g or five pieces to a kg.

The conduct of catfish festivals in 1997 and 1998 in the Zarraga Municipal Plaza also helped gain for the fish more popularity, elevating it to gourmet food level. Some restaurants in Iloilo City started offering the

fish, mostly barbecued or cooked in coconut milk with taro leaves and anatto for food color. Afficionados, gourmands and the average Iloilo family started to look for the fish and its demand started to peak. But until now, the fish can be seldom found in public markets except during special occasions such as fiestas and other festivities. The preference of buyers to get their fish live has remained.

Production

Catfish, mostly *C. gariepinus*, is produced in about 50 ha by more than 400 farmers. The municipalities of Zarraga, New Lucena, Sta. Barbara, Pototan and Dingle are major catfish-producing areas. Almost all these farmers grow the fish in small ponds ranging from 20 to about 2,000 m². Only a few farmers grow the fish in ponds more than one hectare in size.

Estimated volume of production per year is 300 tons. Production is thus a small farm operation and is mostly an income amelioration activity. Catfish and other freshwater fishes caught in the wild, i.e., rivers, streams, swamps and rice farms have dwindled over the years. According to the Iloilo Provincial Agriculture Office, the estimated catch from Iloilo can barely reach 20 tons annually.

The price of catfish has remained high. While the average price per kg of tilapia is P40.00, catfish still sell at P70.00, probably one reason for the continued low demand as an everyday fare. Producers sell the fish at that price due to the high cost of fingerlings and feeds. Commercial catfish feeds cost high and alternatives such as trash fish, abattoir by-products and other protein sources are not regularly available.

Future trends and other developments

An agreement was signed in September 1999 between the Iloilo Provincial Government and SEAFDEC/AQD to reestablish

the preferred native catfish (*C. macrocephalus*). This paved the way to the eventual return of *C. macrocephalus* to the tables of Iloilo residents. The initial reseeding of Tigum River in the watershed of Maasin restocked the head waters of the river where the fish is hoped to find breeding habitats. Fingerlings washed downstream can grow in ponds, rice farms and other water bodies.

Farmers and cooperators of the Iloilo Provincial Government also received breeders of *C. macrocephalus* hatched and raised by AQD. These breeders will later be used to produce seed stocks for sale or distribution to farmers and for the re-seeding of the other rivers and water bodies of the province.

As part of the agreement, AQD trained five government personnel and one farmer leader in captive breeding and hatchery operation of *C. macrocephalus*. These personnel are now conducting training for interested farmers, entrepreneurs and cooperatives so that hatchery technology can be spread speedily throughout the province.

The farmers and entrepreneurs who were trained have started to raise their own brood stocks of *C. macrocephalus* captured in other islands of the country, particularly Cebu, Leyte, Palawan and Mindanao. This initiative is seen to widen the genetic base of the native catfish in the province, hopefully ensuring the sustainability of the industry.

Meanwhile, the return of the native catfish is eagerly awaited by the catfish-eating population of Iloilo. Those who had missed the fish contend that it is superior in taste to both *C. gariepinus* and *C. batrachus*.

Initial sale by an AQD cooperator, Mr. Thomas Hautea in early 1999 was optimistically received by buyers, even though the fish was sold at P150.00 (US\$3.50) per kg



mangrove nursery ... from page 8

vides aeration and serves as fertilizer to the seedlings when decomposed.

To prepare the potting media:

- collect soil (garden type) within the vicinity of the nursery
- screen the soil to exclude plant debris, stone and other unnecessary materials
- mix the soil and coconut coir dust in 2:1 ratio and place in appropriate plastic bag [e.g., black polyethylene (PE) bags]. Table 2 shows the recommended sizes of potting bags

Seed collection

Time and location

Collect seeds or propagules of different mangrove species in highly diversified mangrove areas like Pagbilao, Quezon; San Juan, Batangas and in Ulugan Bay, Macarascas, Puerto Princesa, Palawan.

Generally, all mangroves flower and bear fertile seeds and propagules every year. Collect mature seeds or propagules while they are still attached to the mother tree to ensure high percentage of germination. Table 3 shows the different collection areas and fruiting season in south central Luzon.

Seed transport

Transport collected seeds under cool and moist conditions since sunlight and heat can cause low viability. This is especially true for *bakauan* which has larger propagules. Protect the propagules by retaining the pericarp and covering it with banana or coconut leaves. It is also advisable to bundle the propagules in 50s or 100s for easy transport. *Malat*

TABLE 1 Estimated cost for the construction of a 500 m² mangrove nursery

Materials	Quantity	Cost (P)*
Bamboo poles	70 pieces	3,318.00
Coconut fronds (and hauling)	200 pieces	1,580.00
Fish net (used)	9 rolls	13,935.00
G.I. wire	5 kilos	276.50
Labor	3 persons	3,555.00
TOTAL		22,665.50

*Costs are adjusted to 1998 prices, 1 US\$=₱39.50. For bamboo poles, 50 pieces were used for the post; 20 pieces were split as rafters for roofing

TABLE 2 Recommended sizes of potting bags

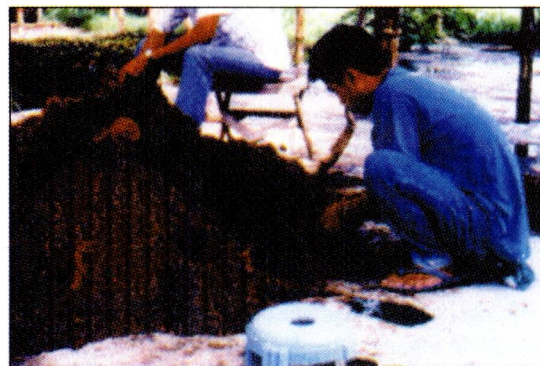
Mangroves	Bag size
Bakauan babae	7" x 11"
Bakauan lalaki	6" x 10"
Bakauan bangkau	6" x 10"
Talisai	6" x 10"
Dungon-late	6" x 10"
Api-api	6" x 10"
Bungalon	6" x 10"
Pagatpat	6" x 10"
Tangal	5" x 8"
Malatangal	4" x 6"
Saging-saging	4" x 6"
Pototan lalaki	4" x 6"
Kulasi	4" x 6"
Nilad	4" x 6"

tangal, *tangal*, *saging-saging* and other mangrove species having small propagules can easily be placed in moist containers such as jute sack.

In case of wildlings, always make sure that the roots are intact. Transported wildlings should be placed in jute sacks to protect them from excessive heat and evaporation. Place the wildlings in potted media right away to prevent drying.

Seed storage

It is better to keep unpotted propagules/seeds for no more than two weeks. Always



Mixture of soil and coconut coir dust as potting media in mangrove seedling production



Bundling bakauan propagules in 50s or 100s makes transport easy

make sure that potting materials are prepared first to avoid long storage. If this is not feasible, or when potting has to be continued the next day, restore the seeds or propagules in their jute sacks and keep them in a cool, dry place.

Seed sowing

Sow the seeds or propagules in appropriate bags and place in shaded area. Here are some pointers:

- water the potting media prior to sowing
- sow the seed or propagule carefully. Burrow one-third of the propagules in case of *bakauan*, *tangal*, *malatangal* and other similar species. In case of *bungalon*, *api-api*, *dungon-late*, *talisai* and other similar species, insert the seeds in plastic bags and place pulverized potting media over the seeds
- raise potted wildlings in the nursery for 30-45 days before outplanting
- water the seeds or propagules after sowing
- group the potted seeds or propagules by species
- label carefully by species for easy identification



Propagules of bakauan bato potted in the nursery



Coconut fronds or kayakas can shade the growing mangroves very well

Maintenance and protection

Watering

Water the seedlings early in the morning and late afternoon to ensure high survival and better growth. Freshwater and brackishwater are recommended over saltwater because high salinity (above 34 ppt) causes stunting and wilting of the seedlings. The salt accumulated in the surface will seal pore spaces and cause very low infiltration of water, and affect the growth of plants. The seedlings are also prone to the attack of barnacles if submerged during high tide. Streams and deep wells (*balon*) are the best sources of water.

Shading

Shading is essential in nursery operation as it protects the seedlings from direct exposure to sunlight and heavy rains. Coconut fronds (*kayakas*) are highly recommended.

Weeding

Remove weeds when necessary to prevent competition for soil nutrients.

Fertilization

Apply one tablespoon of complete fertilizer (14-14-14) to each seedling 30 days after sowing.

TABLE 3 Places of collection and fruiting season of different mangrove and beach species in south central Luzon

Places of collection	Species	Fruiting season
Pagbilao, Quezon	Malatangal	April-July
	Bungalon	June-July
	Api-api	June-July
	Nilad	May-June
	Dungon-late	April-May
Unisan, Quezon	Talisai	April-May
	Nilad	May-June
	Pototan lakai	May-July
	Saging-saging	June-July
	Bungalon	June-July
	Api-api	June-July
	Malatangal	May-July
	Bakauan lalaki	Year round
	Bakauan babae	Year round
	Pagatpat	June-July
Matandang Sabang, Catanauan, Quezon*	Pototan lalaki	May-July
	Tangal	May-July
	Malatangal	May-July
Catmon, San Juan, Batangas	Pototan lalaki	May-July
	Bungalon	June-July
	Malatangal	May-July
	Saging-saging	July
Nagsaulay, San Juan, Batangas	Malatangal	May-July
	Tangal	May-July
	Bakauan babae	Year round
	Bakauan lalaki	Year round
	Bakauan lalaki	Year round
Parañaque/Las Piñas**	Bakauan bato	Year round
	Bakauan babae	Year round
	Pagatpat	July-August
	Bungalon	June-July
	Pototan lalaki	June-July

*ERDB aquasilviculture project site

**ERDB coastal road rehabilitation project site

Protection from pests and stray animals

Fence the nursery with bamboo and fish net. Conduct regular inspection of the seedlings to prevent any outbreak of pest infestation. Table 4 presents the different insect pests and diseases attacking mangrove seeds or propagules and seedlings.

Hardening

Mangrove seedlings must be "hardened" in the nursery prior to outplanting. This is done to acclimatize the seedlings to the local weather conditions. Conduct hardening operation one to two months before outplanting. Table 5 shows the time for sowing and outplanting.

next page

TABLE 4 Damage and control for pests/diseases of mangrove propagules and seedlings

	Damage	Control measure
Insect pests		
Tussock moth	larvae or hairy caterpillar feeds on leaves of young seedlings	manual removal and killing of larvae
Seed borer, <i>Poecilips fallax</i>	burrow into propagules and breed on the seedling	exclude propagules with holes
Aphids	suck the nutrients off <i>bakauan</i> seedlings	insecticide spray
Scale insect	suck the nutrients from leaves, causing leaves to curl	insecticide spray
Slug caterpillar	defoliation	manual removal of larvae
Bagworm	defoliation	manual removal
Diseases		
Leaf spot	brown spot interferes with photosynthesis; defoliation if severe	removal of infected leaves and burning
<i>Bakauan</i> mosaic	defoliation, interferes with photosynthesis	removal and burning of infected seedlings

TABLE 5 Schedule of sowing and outplanting of selected mangrove/beach species

Species	Sowing	Outplanting	Age of seedlings
Bakauan babae	June	September-October	4-5 months
Bakauan lalaki	June	September-October	4-5 months
Tangal	June	August-September	3-4 months
Malatangal	June	August-September	3-4 months
Saging-Saging	June	August-September	3-4 months
Pototan lalaki	June	August-September	3-4 months
Dungon-late	June	Nov. to December	6-7 months

Concluding remarks

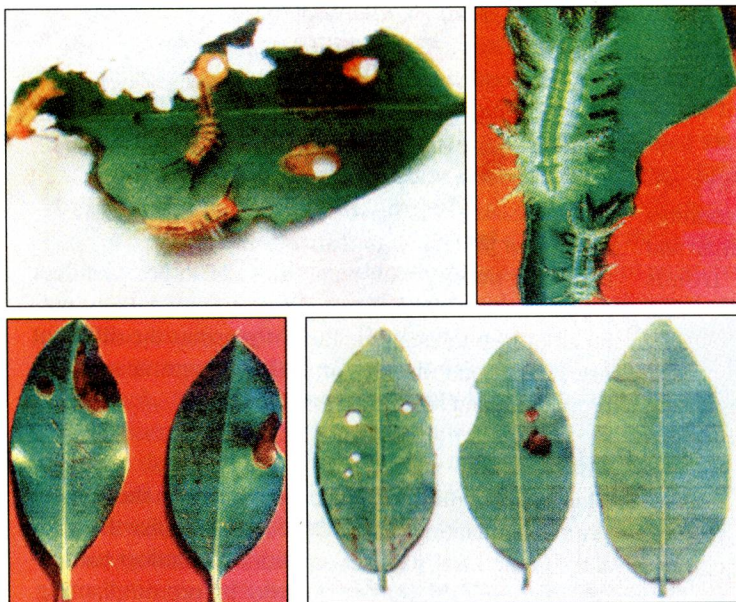
The need to reforest or rehabilitate the denuded mangrove swamps and coastal areas is of national concern. The establishment of mangrove nurseries is in line with government's effort to rehabilitate the coastal and mangrove ecosystems.

The nursery is a place for raising and tending seedlings until they are ready for permanent planting. It plays a very important role in any planting activity as it provides the necessary planting stock for reforestation and other planting operation with high percentage of survival. It also serves as a gene bank for different mangrove species.

Therefore, in areas where it is difficult to plant mangroves and to assure success of mangrove reforestation, a nursery is a must.

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LEFT, CLOCKWISE *Tussock moth*, *slug caterpillar* and *bagworm* feeding on *bakauan*, and the looks of the *leaf spot* disease



role of vitamins ... from page 10

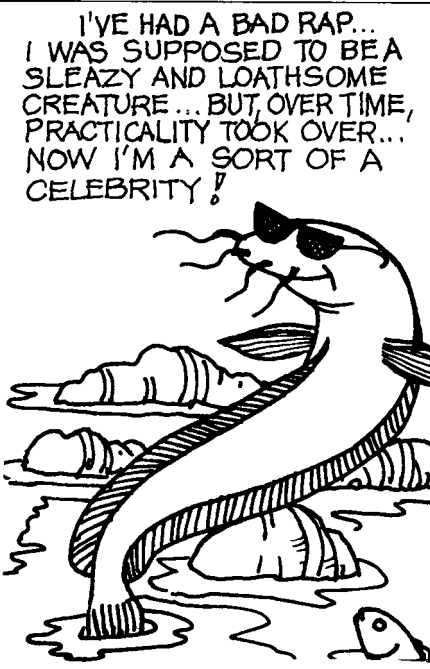
The safety level of vitamin E has to be determined before administration (Waagbo 1994). According to Pulsford *et al.* (1995), the phagocytic activity of kidney macrophages in flat fishes were enhanced when the fishes were fed higher amounts of vitamin E.

Conclusion

Still no clear conclusions can be drawn with respect to vitamin nutrition and fish immunity. So, attention should be given to improve the earlier recommended levels for different vitamins.

- Testing with different immune functions must include the mechanism by which a single nutrient accelerates different biological functions
- Safety levels of different vitamins must be determined before administration
- For antioxidant vitamins, care should be taken to avoid losses due to atmospheric oxidation and water leaching by using the recommended type such as phosphate esters of ascorbic acid
- More work is needed for vitamins C and E supplementation beyond minimum dietary requirements to clarify the benefits to fish health. So, metabolism of nutritional C and E forms needs further investigative biochemistry

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golden apple snail ... from page 12

periods and possibly even during the dry period, as these burrow deep into the soil.

A female GAS can lay 25-320 eggs at one time. Incubation ranges from 10 to 15 days, and, depending on the temperature of the microenvironment, GAS normally lives from two to three years. The GAS do not feed only on rice. They also damage many cultivated and non-cultivated plants such as a lotus (*Nelumbo nucifera*), taro (*Colocasia esculenta*), duckweed (*Lemna minor* L.), swamp cabbage (*Ipomoea aquatica*), mat rush (*Juncus decipiens*), water chestnut (*Trapa bicornis*), and water fern (*Azolla* spp.). It has a wide range of possible hosts and food substrate such as commercial livestock feeds, decaying matter, animal flesh, and other important crops. Because of this, GAS is difficult to control. Compounding this problem is the occurrence of heavy rains and the application of pesticides that kill a large number of beneficial organisms, particularly in and around the rice ecosystem.

TABLE 1 Volume of molluscicides purchased, 1980-1998, Philippines

YEAR	VOLUME (kg per ha)
1998	67,340
1997	241,683
1996	130,000
1992	180
1991	159
1990	0
1989	25
1988	64
1987	9
1986	6
1985	3
1984	3
1983	0
1982	0
1981	0
1980	0

Note: Does not include 1993-1995 data
Source: Fertilizer and Pesticide Authority, 1999

Molluscicides have been widely used to control GAS but these can also kill non-pest snails and other beneficial organisms. From 1980 to 1988, the volume of molluscicides purchased increased (Table 1). The biggest volume recorded was in 1997, when about 241,683 kg per ha were purchased. The country has already spent about US\$23 million from 1980 to 1998 for molluscicides (Fig. 1).

The Strategic Extension Campaign launched in 1989 by the Food and Agriculture Organization (FAO) of the United Nations, Visayas State College of Agriculture (VISCA), International Rice Research Institute (IRRI) and DA-PhilRice introduced non-chemical methods such as pasturing ducks in rice fields after harvest, handpicking, destroying egg clusters before final harrowing, transplanting older seedlings, and installation of screens in water inlets. These practices however, remain untested in the rainfed, direct-seeded, and

page

golden apple snail ... fr previous page

hybrid rice production environments.

Joshi's team is currently conducting intensive GAS research focusing on life table analysis, off-season survival strategies, and crop compensation. According to Joshi, knowledge on the biology of the GAS can lead us to discovering more effective control measures. He also said that current control measures are not very effective if not done at the community level.

GAS study at DA-PhilRice

Studies conducted by DA-PhilRice aimed to establish the effectiveness of basal application in the reduction of GAS population and the relation of GAS shell length to rice seedling damage. Results showed that GAS with shell length of 40 mm are most destructive to rice seedlings, while GAS with shell length of 5 mm and below were not capable of destroying rice seedlings (Fig. 2). Another study documented the current status of GAS infestation in the IRT. The study was conducted in collaboration with the local government units (LGU) of the municipalities of Banaue, Mayoyao, and Hungduan and with DA, Lagawe, Ifugao. The study focused on the extent of damage and distribution; and knowledge and current control practices applied by farmers. Majority of farmers in the lowland areas uses molluscicides, while others chose to handpick the GAS and pasture ducks in the fields. In the IRT, farmers use indigenous plants and decaying weeds as attractants, the most popular of which is the trumpet flower.

Prospects for further research

A more intensive study on the biology of the GAS is needed to develop more effective control measures. One possible solution is the use of indigenous plants as attractants. In the lowland areas, farmers use kangkong (*Ipomea aquatica*), sweet potato (*Ipomea batatas*), and papaya (*Carica papaya*) as attractants.

Another promising method is integrating fish in the rice culture. Fish is integrated

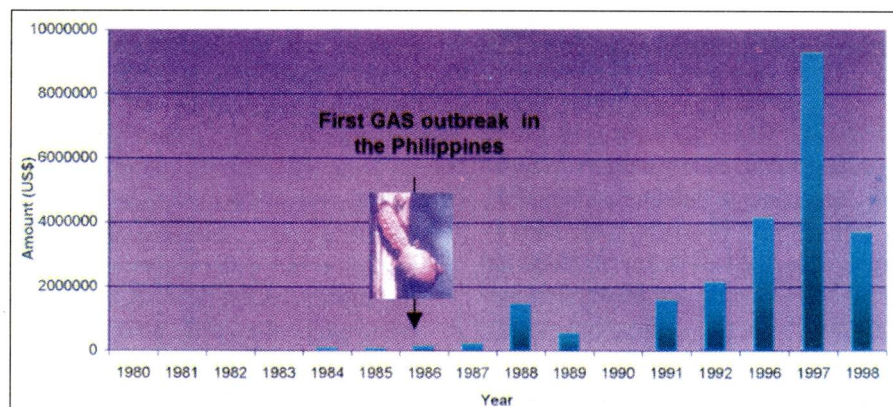


FIG 1 Total amount spent for golden apple snail control using molluscicides, 1980-1998, Philippines (from FPA 1999)

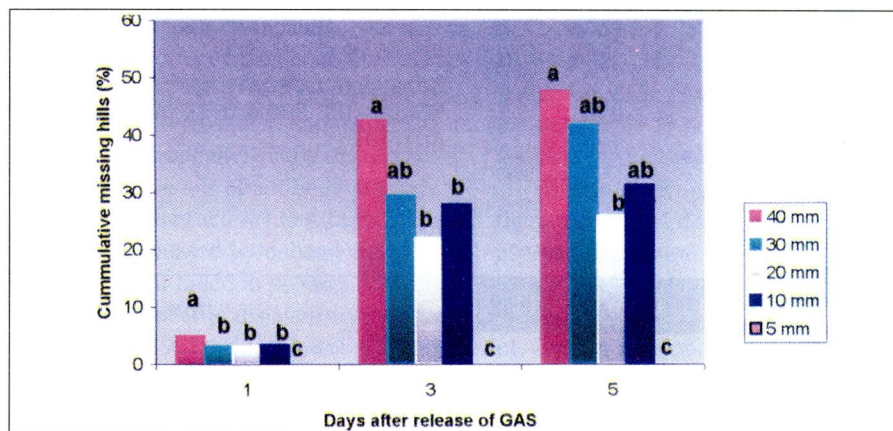


FIG 2 The effect of different golden apple snail sizes on rice seedling damage. Bars sharing the same letters are not significantly different ($P < 0.05$) according to Duncan's Multiple Range Test (DMRT)

in rice culture because of a number of advantages such as controlling pests, increasing cash and non-cash income and the nutritional intake of farm households. A study conducted by ICLARM in 1996 at Quirino province showed that there is potential for rice-fish culture in upland areas.

The least explored area of GAS research in the Philippines is the use of aquatic predators such as fish, frogs, toads, and other water-borne organisms. Dr. Matthias Halwart of FAO, Rome says that the common carp, *Cyprinus carpio* and *Oreochromis niloticus* can be used in controlling the juvenile stage of GAS. In Taiwan, more than a million fingerlings of the

C. carpio and *Mylopharyngodon piceus* were released to control GAS. However, it is also very important to assess the safety of plants with molluscicidal activity against fishes that feed on GAS.

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next page



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catfish Phil ... from p 24

Summary

The catfish industry in the Philippines is budding and projected to expand in the coming years. This is evident from conversations with active catfish farmers who all hope to be able to expand production, whether backyard or commercial because their present production can hardly supply the demands of buyers.

NIFTDC a fisheries technology and development center in Dagupan City, however, says that unless the government has a catfish program, expansion of the industry would be slow. Work on catfish research is only just starting and the culture methods remain to be on a gut feel basis. The farmers are left to survive on their own. Luckily for them, catfish is hardy, easy to grow, and has a growing market. Clearly, if catfish can provide cheap protein for more people, scientific support must be made available for the farmers.

POSTSCRIPT

The Mangabol Lake (located between the provinces of Pangasinan and Tarlac) used to be the biggest source of catfish (native or hitong tagalog, *C. macrocephalus*) in Luzon, perhaps even the Philippines (Philippine Fisheries, 1952). An annual festival used to be held in the area, according to people in Bautista, Pangasinan. Fishers from all over Luzon would gather in Mangabol Lake, and on the day of the festival, a fog horn would sound and fishers simultaneously dive into the lake with their snare. The diver who got the biggest catch would win a prize (usually prestige). But the 1991 Mt. Pinatubo eruption overran the lake and Mangabol Lake remains to be unproductive until the present time.

Acknowledgement The writers thank the following for their kind assistance while gathering data: NIFTDC Officer-in-Charge Mr. Westly Rosario, Kathy, and Manang of NIFTDC, Ms. Soledad Cruz of the Bulacan Provincial Agriculture Office, Mr. Manuel Igharas of the Municipal Agriculture Office of Pandi, Bulacan, and Mr. Cesar Recio, Noel Bong Claudio, and Mang Nestor Lico of SEAFDEC Manila Office.

SEAFDEC protocol ... from p 19

running water and then placed inside the incubators. Incubators can be made of marine plywood or plastic basin with a flow-through water system and provided with aeration.

Pituitary glands can be dissected from the heads of sacrificed male catfish. Pituitary glands contain hormone(s) that can also be used to spawn the female catfish in subsequent runs.

Fertilization and hatching

Using the above procedure, fertilization rate can reach more than 90%, while hatching rate may range from 30 to 70%. When stripped, there are approximately 100 eggs per gram body weight of the female fish; about 500 eggs are contained in one gram. A female catfish has 20-25 g of stripped eggs on the average.

Hatchery and nursery rearing

Larvae can be maintained for four days in the same incubators without feeding. Catfish larvae are then transferred to bigger tanks and fed with newly hatched *Artemia* nauplii for three days and *Moina* for four days. Thereafter, larvae are given formulated feed of 150-200 microns size that contains 44% protein. Two week-old catfish fry can be sold to grow-out pond operators, who are advised to rear the fry in net cages suspended in either tanks or ponds. Or, the fry are reared further for 4-6 weeks in bigger nursery tanks or ponds to reach 3-5 cm, the appropriate size for stocking in grow-out ponds:

Packaging and transport

Catfish fry are counted and graded according to size, and then placed inside a plastic bag half-filled with water at 500 to 1000 fry per bag. The bag is thereafter oxygenated and tied. Native "bayong" bags may be used to hold the plastic bags in, when transporting a short distance only. When transporting by plane however, the plastic bags are better placed in styrofoam boxes with crushed ice filled to the brim.—NJD



SEAFDEC work ... from p 19

was a need for someone to continue working on the nursery stage. The Fermin couple identified Ms. Ruby Bombeo of the Nursery Section to take over. As Catfish Project Leader, Dr. Fermin further invited Mr. Eliseo Coniza and Ms. Mac Catacutan to join the team. Mr. Coniza just finished his Master of Aquaculture degree from the University of the Philippines in the Visayas. Ms. Catacutan of the Feed Development Section formulated the feeds for weaning, nursery and grow-out. Several people from the private sector bought catfish fry and fingerlings as research by-products from the studies of Ms. Bombeo and Mr. Coniza. The following year, a catfish hatchery production unit was created to provide the seeds to private entrepreneurs who would try the culture of the native catfish. With the help of Engr. Zaldy Suriaga of AQD's Engineering Section, a recirculating system especially during incubation of the eggs was put up. While broodstock may withstand polluted water, eggs need clean, pure, flowing water during incubation.

A typical production run at the AQD hatchery shows that fifty 150-200 g females can produce around 150,000 5-day old larvae with a survival rate of 30-70%. The AQD hatchery sells two week-old fry at P0.50 per piece, while the price of

fingerlings range from P1.00 to P2.50 depending on the size.

When word began to spread that AQD can provide the seeds of the native catfish, many in the private sector were enthusiastic. "Imagine the process of research," Dr. Fermin observed, "it took 10 years and it is only now that it peak up."

This interest may be due to the locals' desire to bring the native catfish back to their tables. Due to a still unidentified cause, the catfish has apparently long disappeared in natural waters. Many Filipinos want it back, because they claim that the meat of *C. macrocephalus* is more tender and delicious than that of the African catfish *C. gariepinus* and the other Asian catfish *C. batrachus*. Some of the Freshwater Aquaculture Training participants from Thailand also attest to the higher prices *C. macrocephalus* command in their homeland.

AQD now receives orders twice or thrice a week for catfish fry or fingerlings from private hatcheries, fishery schools and local governments. Provincial governments are enthusiastic about restocking inland freshwater waterways with the AQD hatchery-produced fry.

AQD is collaborating with the Office of the Governor of Iloilo for the restocking program. The Catfish Project researchers and staff conducted a free lecture and hands on training on breeding, hatchery and nursery operations of the native catfish for 2

weeks in September 1999. Moreover, AQD also has a tie up with DA-BFAR to accelerate the techno-transfer of mature technologies developed, which includes catfish. This program aims to increase fish production and revenues from the aquaculture sector, and provide alternative livelihood to fisherfolks.

When asked what concerned her the most regarding the industry, Dr. Fermin remarked of hopes for the industry to pick up the catfish technology, which aside from being mature and feasible, requires less capital than the other carnivorous aquaculture species. "It is easy and can be done in one's own backyard," she pointed out.

Dr. Fermin envisions many forthcoming catfish studies. She plans to do an economics study of the catfish hatchery, as well as determine the cause of disappearance of the native catfish in the Philippines. Genetic characterization has to be done in collaboration with Dr. Zubaida Basiao of AQD's Binangonan Freshwater Station, and simultaneously, develop tagging techniques to mark the release of hatchery-bred fingerlings in natural habitats.

Her final words: "I just hope that the private sector would bear with us for a little while, because research that is tested and proven takes time to perfect. It is different when one's studies have sound scientific bases because one can be confident and sure that it will work. And this is so with the native catfish." ###

Iloilo market ... from p 27

both in Zarraga and in the gourmet restaurants of Iloilo City. This high price added to the interest in growing the fish even though it is slower growing than the *batrachus* and the *gariepinus*. The hatchery technique perfected by AQD scientists and promoted by government technicians will also stabilize the supply of seed stocks.

The provincial government is actively promoting the fish as a source of high qual-

ity and affordable protein. It has published a brochure distributed throughout the province, urging the people to grow the fish for added income from rice farm. The brochure is part of a series promoting rice-based integrated farming as a means to increase the productivity of rice farms. The Provincial Governor, Honorable Arthur Defensor, also created the Technology and Livelihood Development Center to spearhead

the access of technologies including fisheries technologies and transfer them to farmers and entrepreneurs in the Province.

REFERENCES

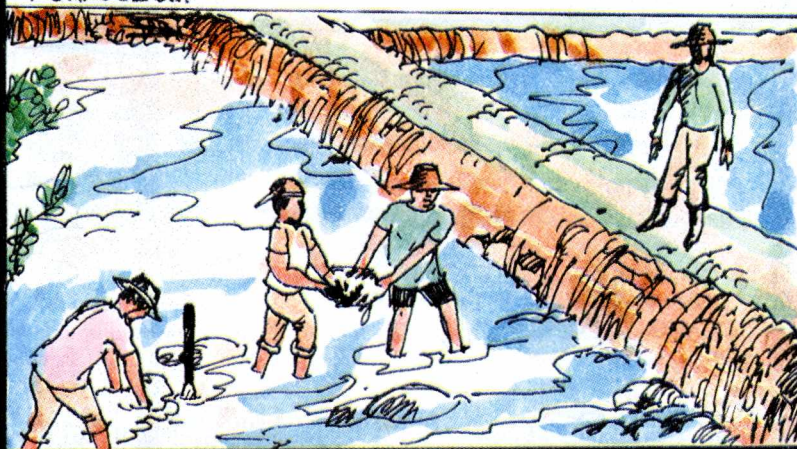
- Pet Milleza, "Zarraga farmers hold catfish festival," Capitol News Release, April 21, 1998
- Provincial Agriculture Office. 1997 Annual Report

AQUACULTURE ILLUSTRATED

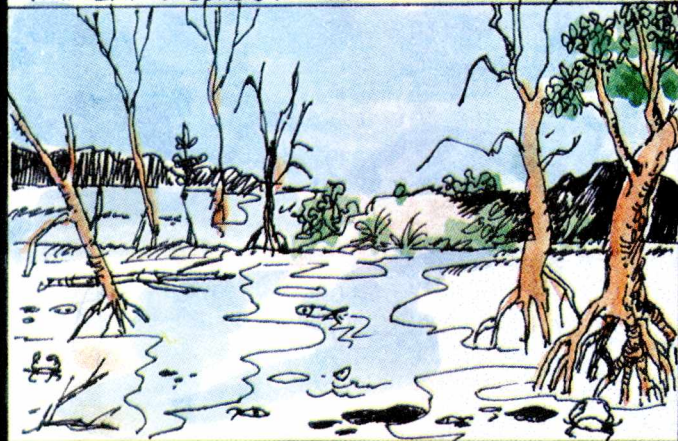
by a.p. surtida &
e.t. ledesma

Mangroves and Mudcrabs

AQUACULTURE AND MANGROVES NEED NOT BE ADVERSARIAL. IN THE PAST THE PHILIPPINES USED ABOUT 200,000 HECTARES OF MANGROVE AREAS FOR FISHPOND PURPOSES...



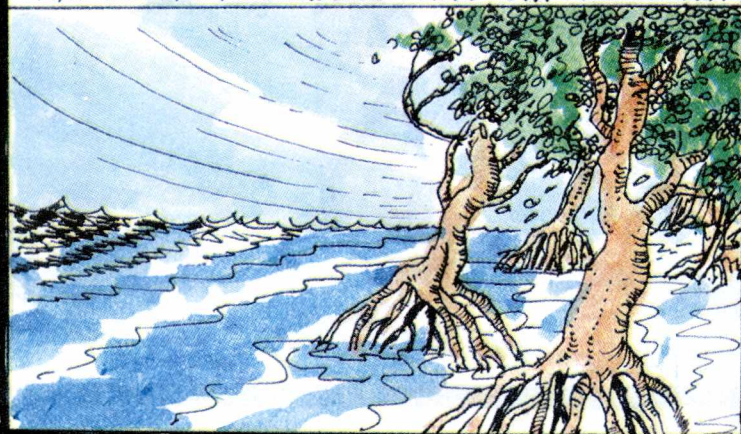
WITH THIS CONDITION, THE PRODUCTIVITY OF CAPTURE FISHERIES FOR SHRIMPS AND CRABS AS WELL AS FISH WHICH USE MANGROVES AS NURSERY GROUNDS HAS BEEN ADVERSELY AFFECTED...



OTHER MANGROVE USES ARE COMMON KNOWLEDGE: FIREWOOD, CHARCOAL, CONSTRUCTION MATERIAL, ROOFING AND FOOD AND BEVERAGES...



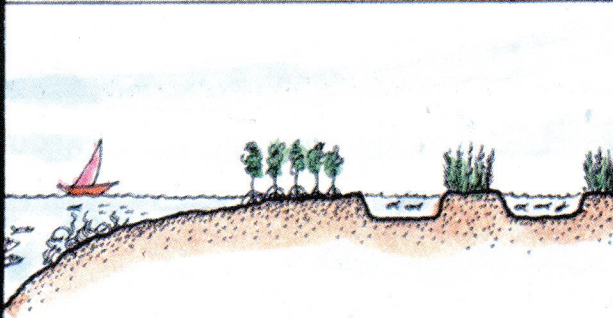
IN ADDITION, MANGROVES ALSO PROTECT THE COASTS FROM TYPHOONS AND STORM SURGES, PREVENT EROSION OF RIVERBANKS AND SHORELINE AND ABSORB POLLUTANTS FROM BOTH LAND AND SEA...



THE INCREASING MILITANCE OF THE GLOBAL ENVIRONMENTAL MOVEMENT AND THE THREAT OF TRADE EMBARGOES MADE GOVERNMENT REALIZE THE FOLLIES OF THE PAST... AT LAST MANGROVE, ALONG WITH CORAL REEF CONSERVATION HAS BEEN GIVEN ATTENTION, WHICH HAS LONG BEEN DUE...



TO RECONCILE AQUACULTURE AND MANGROVES, IT IS IMPORTANT TO UNDERSTAND THE CONCEPT OF AQUASILVICULTURE, OR THE INTEGRATION OF AQUACULTURE WITH MANGROVE SYSTEMS.

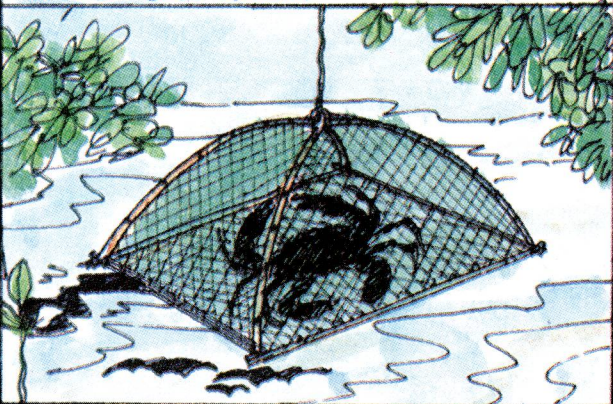


TRANSECT OF AN AQUASILVICULTURE FARM OF THE SUR FAMILY
PUERTO GALERA, MINDORO, PHILIPPINES

IN AN AQUASILVICULTURE PROJECT OF SEAFDEC/AQD IN Aklan Province, Central Philippines, for example, mudcrabs are grown in pens installed in tidal flats with existing mangroves. The project is run by a village cooperative with technical support from AQD...



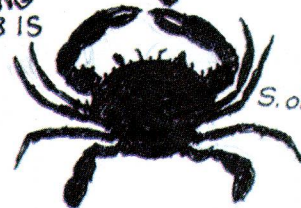
CRABS OF THE GENUS SCYLLA ARE STRONGLY ASSOCIATED WITH MANGROVE AREAS THROUGHOUT THE PACIFIC AND INDIAN OCEANS AND FORM THE BASIS OF SUBSTANTIAL FISHERY AND AQUACULTURE OPERATIONS. HENCE, THEY ARE EXCELLENT SPECIES FOR CULTURE IN EXISTING MANGROVE AREAS WHETHER FATTENING OR GROW-OUT OF JUVENILES TO MARKETABLE SIZE...



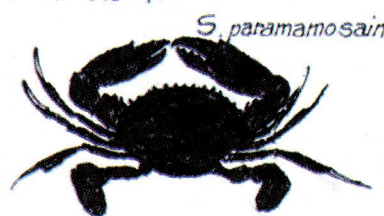
AMONG THE FAMILIAR SCYLLA SPECIES ARE: S. OLIVACEA, S. SERRATA, S. TRANQUEBARICA AND S. PARAMAMOSAIN... OF THE FOUR, S. SERRATA, LOCALLY KNOWN AS KING CRAB OR GIANT CRAB IS PREFERRED BY CRAB FARMERS BECAUSE OF THEIR SIZE AND FAST GROWTH THEY CAN REACH ONE KG. IN JUST SIX MONTHS...



S. serrata



S. olivacea

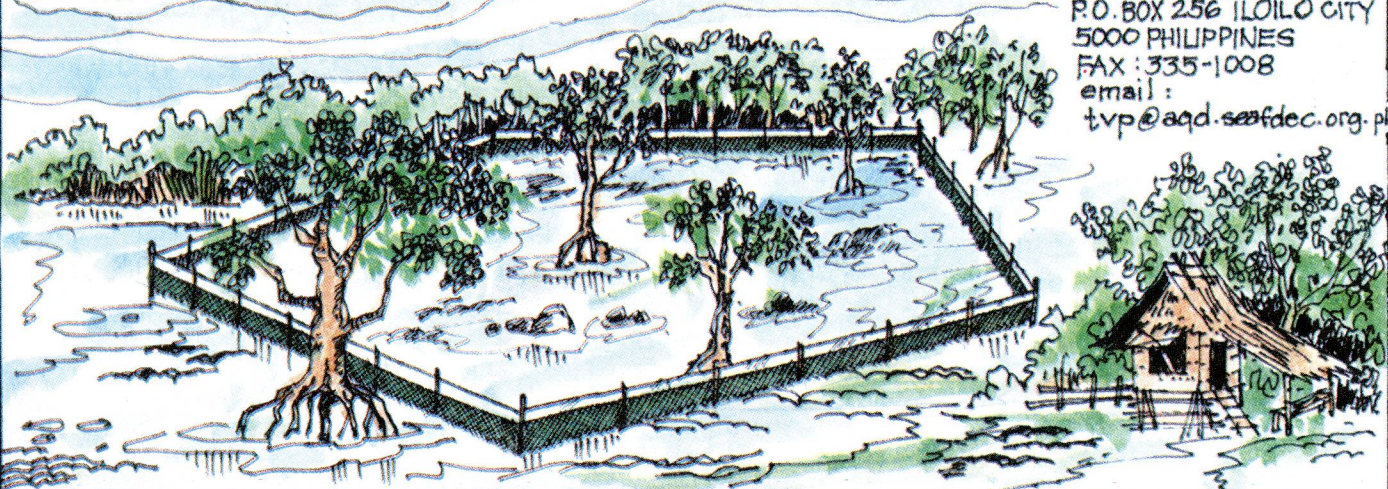


S. paramamosain



S. tranquebarica

MUDCRAB CULTURE IN MANGROVES OR TIDAL FLATS IS ECOLOGICALLY-FRIENDLY BECAUSE IT DOES NOT DESTROY MANGROVES AND MOSTLY USES LOCALLY AVAILABLE MATERIALS. THE NET ENCLOSURES REQUIRE A RELATIVELY SMALL INVESTMENT TO CONSTRUCT AND OPERATE...



FOR MORE INFO
WRITE TO :
RESEARCH DIVISION HEAD
P.O. BOX 256 ILOILO CITY
5000 PHILIPPINES
FAX : 335-1008
email :
tvp@aqd.seafdec.org.ph

A2D Training courses **NOTICES**

Year 2000 AQD TRAINING COURSES

Third Country Training Program on Responsible Aquaculture Dev'l (TCTP, 1st session)	January 18 to March 17
Fish Health Management	April 26 to May 31 (5 weeks)
Freshwater Aquaculture	April 4 to May 3 (4 weeks)
Management of Sustainable Aquafarming Systems (includes module on Aquaculture Management)	May 30 to July 5 (5 weeks)
Marine Fish Hatchery	June 6 to July 14 (5 weeks)
TCTP, 2nd session	August 7 to October 6 (8 weeks)

For application forms and further information, please contact:

Training and Information Division
SEAFDEC Aquaculture Department
Tigbauan, Iloilo 5021, Philippines
Tel/fax: 63 (33) 336 2891, 335 1008
E-mail: tid@i-iloilo.com.ph; training@aqd.seafdec.org.ph

For local applicants who wish to apply for fellowships, contact:

Hon. Cesar Drilon, SEAFDEC Council Director for the Philippines
Office of the Undersecretary for Fisheries and Legislative Affairs
Department of Agriculture, Elliptical Road, Diliman, Quezon City 1104
FAX: (02) 927 8405

For fellowship applicants from other countries, please contact your respective SEAFDEC Council Director.

Videos from SEAFDEC/AQD

Milkfish hatchery operations, 12 minutes. Describes SEAFDEC/AQD's recommended mode of operations for a milkfish hatchery. Price (including postage): P350 in the Philippines; US\$35 for other countries.

A CFRM experience: the Malalison story, a 30-minute video documentary that shows the processes and lessons gained by SEAFDEC's 7-year coastal fishery resource management project (CFRM) in Malalison Island, west central Philippines. Price (including postage): P500 within the Philippines; US\$45 for other countries.

Culture of oyster and mussel using raft method, a 9-minute documentary that depicts the AQD favored method of using the environment-friendly hanging raft for oyster and mussel culture. Price (including postage): P350 in the Philippines; US\$35 for other countries.

Grouper cage culture, 16 minutes. Promotes a profitable way of raising grouper in cages. Describes briefly the processes of site selection, cage construction, and grow-out culture. Price (including postage): P350 in the Philippines; US\$35 for other countries.

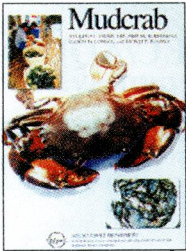
Grouper culture in brackishwater ponds, an 8.5-minute video documentary showing the different stages of grouper culture: grow-out, harvest, and post-harvest, as well as site selection and pond preparation. It also describes the economics of one grouper crop, and marketing and transport techniques. Price (including postage): P350 in the Philippines; US\$35 for other countries.

Conserving our mangrove resources, a 12-minute video documentary that describes the plight of mangroves in the wake of the fish-pond boom and efforts to sustain the mangroves. Price (including postage): P400 within the Philippines; US\$40 for other countries.

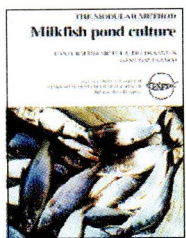
SEAFDEC websites on the internet

- **www.seafdec.org**
maintained by the SEAFDEC Secretariat and SEAFDEC Training Department in Samut Prakan (Thailand) with contributions from the various SEAFDEC departments. Regional programs are highlighted
- **www.seafdec.org.ph**
all about the SEAFDEC Aquaculture Department based in Iloilo, Philippines
- **www.asean.fishnet.gov.sg/mfrd1**
all about the SEAFDEC Marine Fishery Research Department based in Singapore
- **www.agrolink.moa.my/dof/seafdec**
all about the SEAFDEC Marine Fishery Resources Development and Management based in Kuala Terengganu, Malaysia

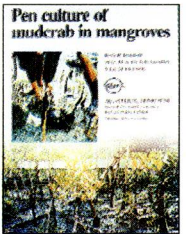
New publications



Mudcrab, a 32-page manual that gives a general overview of mudcrab species of commercial value and their grow-out monoculture in ponds; polyculture with milkfish; and fattening in ponds, mangroves, and cages. *Price (including postage): P100 in the Philippines, US\$ 35 other countries.*

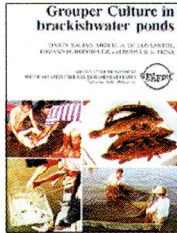


The modular method: milkfish pond culture, an 18-page manual that describes a better way of raising milkfish in brackishwater ponds. The modular method is an improvement of the traditional extensive method. *Price (including postage): P80 in the Philippines, US\$ 30 other countries.*



Pen culture of mudcrab in mangroves, a 10-page manual that details the operation of net enclosures in mangroves for mudcrab culture. Includes site selec-

tion, net installation, stock management, and marketing. *Price (including postage): P80 in the Philippines, US\$ 30 other countries.*



Grouper culture in ponds, a 17-page manual discussing basic information about groupers and detailing brackishwater pond culture: sourcing fry and fingerlings, site selection, pond preparation, nursery operation, grow-out culture, harvest, and post-harvest. It also describes the economics of one grouper crop, marketing and transport techniques and diseases. *Price (including postage): P80 in the Philippines, US\$ 30 other countries.*

Sea bass hatchery operations, a 42-page manual updating AQD's 1990 publication of the same title. It details the activities in the seabass hatchery, from breeding until the harvest and transport of fry to fishponds. New section on the propagation of natural food *Moina* and *Diaphanosoma* has been added. *Price (including postage): P100 in the Philippines, US\$ 30 other countries.*

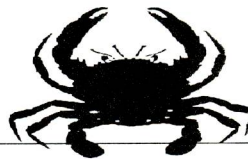
Biology and culture of siganids, a 53-page monograph updating AQD's 1990 publication of the same title. The book includes siganid morphology, distribution and ecology; reproduction; fisheries; diseases and parasites; genetics. It also covers larval culture; fry and fingerling production; nutrition and feeds; and problem areas in aquaculture. *Price (including postage): P100 in the Philippines, US\$ 30 other countries.*

Aquaculture newsletter

Since June 1997, we have merged our two newsletters -- *Aqua Farm News* and *SEAFDEC Asian Aquaculture* -- into a new *SEAFDEC Asian Aquaculture*, the newsletter you're reading now. Update your newsletter subscription (use form below).

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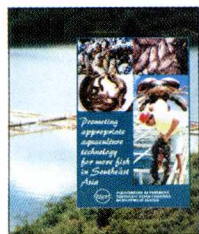
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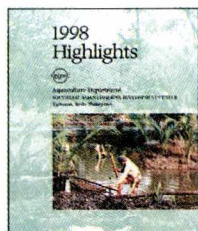
Flyers

SEAFDEC/AQD Reports



Promoting appropriate aquaculture technology for more fish in Southeast Asia, 24 pages, June 1999

Discusses AQD's technology verification trials on (1) milkfish hatchery, pond culture using hatchery-raised fry, and polyculture of milkfish and seaweeds; (2) the use of environment-friendly schemes in tiger shrimp culture; (3) mudcrab culture in ponds and net enclosures in mangroves; (4) cage culture of hybrid tilapia; (5) catfish hatchery technology; and (6) oyster and mussel culture in rafts.



1998 Highlights, 31 pages, June 1999

Reports on AQD's research and development activities for 1998. A special insert on AQD's 25th year anniversary celebration is included, describing the organization's contributions to the aquaculture industry in the Philippines and other Southeast Asian countries. What's new for 1998 is AQD's thrust on mangrove-friendly aquaculture; preliminary results are presented.

These reports are free upon request.

Conference proceedings

Papers presented at the *Second international conference on the culture of penaeid prawns and shrimps* held 13-17 May 1996 at Iloilo City, Philippines appear in a special issue of the journal *Aquaculture*, volume 164, 374 pages. This journal volume is guest-edited by AQD researchers ET Quintio and JH Primavera. Price: ₱600 in the Philippines or US\$30 other countries.



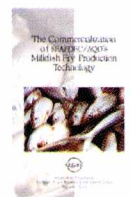
The farming of Kappaphycus. Introduces the red seaweed *Kappaphycus* with notes on the types of culture systems, the environmental factors required, initial investment needed, and crop management.



Milkfish breeding and hatchery fry production. Summarizes the integrated milkfish broodstock and hatchery operation technology developed by AQD.



Milkfish breeding and hatchery technology at SEAFDEC/AQD. Describes the techniques already adopted by the private sector: broodstock management, broodstock diet, commercial fry production, live transport, and larval diet. A list of AQD research publications on milkfish is included.



The commercialization of SEAFDEC/AQD's milkfish fry production technology. Illustrates AQD's newest hatchery facility -- the Integrated Fish Broodstock and Hatchery Demonstration Complex -- and the extension program that go with it -- Accelerated Transfer of Milkfish Fry Production Technology.



Reaching out through technology verification and extension. Presents the efforts of AQD to fast-track commercialization of aquaculture technologies developed

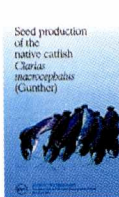


Binangonan Freshwater Station. AQD's R&D on freshwater aquaculture and lake ecology, primarily the Laguna de Bay, is conducted in this station. Species prioritized for research include tilapia, carp and catfish.

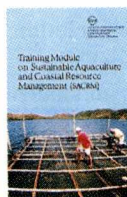
These flyers are free upon request.



Mudcrab culture. Summarizes the available technologies on mudcrab grow-out -- monoculture in ponds, polyculture with milkfish in ponds, monoculture in tidal flats with existing mangroves -- and mudcrab fattening. Details on stocking density, some management tips and investment costs are given.



Seed production of the native catfish Clarias macrocephalus. Describes SEAFDEC/AQD's work on artificially propagating the catfish.



Training Module on Sustainable Aquaculture and Coastal Resource Management. Describes the new SEAFDEC/AQD training course (including course content), qualification of participants, and enrollment process.

Brochure

Aquaculture training program. 20-page brochure that introduces SEAFDEC/AQD's short-term regular courses.



NEW!

"Mudcrab *Scylla* spp. Production in Brackishwater Ponds"

A manual by SEAFDEC's technology verification staff Dan Baliao, Miguel de los Santos and Nilo Franco.

It covers the specifics of grow-out operation -- site selection, pond specification, pond preparation, source of juveniles, transport and stocking, care of pond and stock, feeds and feeding, harvest, postharvest.

Also includes costs-and-benefits analysis and a list of useful references.



Milestones in catfish R&D

The freshwater catfish *Clarias macrocephalus* is native to the Philippines but is fast becoming scarce in many natural habitats.

It is a favorite food fish due to its tender and delicious meat. Recently, farming of *C. macrocephalus* has gained interest among catfish growers as it is resistant to diseases, can be stocked at high densities, and tolerates low water quality.

Efforts have been poured into developing catfish culture technologies. For SEAFDEC/AQD, work has been focused on broodstock and hatchery technology.

Here are the milestones in AQD's research on *C. macrocephalus*:

YEAR	
1989	first induced spawning of adults from the wild
1990	completion of the catfish life cycle in captivity
1992	breeding techniques established for captive adults
1994	regular production of fry in the hatchery
1995	start of training courses including catfish hatchery
1996	formulation of broodstock diet
1997	refinement of breeding and hatchery techniques

Technology for raising *C. macrocephalus* is now available.

The Hautea fishfarm in Iloilo is where most of the nursery techniques for catfish have been verified and tested in commercial scale



**MORE
STORIES
INSIDE.**



Better life through aquaculture

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Agrikulturang



MakaMASA

Makapagpabagong Programa Tungo sa Masagana
at Maunlad na Agrikultura at Panglagaan

SEAFDEC Aquaculture Department supports the Philippine government's **Agrikulturang MakaMASA** program. This is the banner program of the Estrada Administration for modernizing the agriculture sector.

The goals of the program for the fisheries sub-sector are: (1) food security through sustainable development and management of fisheries resources; (2) socio-economic upliftment of subsistence fisherfolk; and (3) fisherfolk empowerment. The program components are as follows:

- fisheries production
- conservation and management
- fisheries training and extension services
- fisheries information and marketing support
- research and development in fisheries
- fisheries infrastructure
- rural finance for fisheries
- program organization and management for the fisheries sector